Concrete

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"Better Concrete" Was Theme of American Concrete Institute Sessions

SELDOM in any convention does one see a group of men more in earnest than were the 650 delegates who attended the twenty-fourth annual convention of the American Concrete Institute at Philadelphia, February 28th to March 1st, inclusive.

The steadily growing strength of the Institute and the widening scope of its influence were shown not only in the greater attendance but in the active interest and the lively discussions featuring the various sessions. If any particular trait could be considered as typical of the entire convention, it would be the evident desire to get at the real facts underlying the various subjects discussed. Here was a group of serious-minded men, deliberately searching out any possible shortcomings of the industry they represented. Where such shortcomings were found to exist, they were frankly and fearlessly hailed into court and tried. Can such frank, constructive examination result in anything but progress for the industry?

Wide Range of Subjects

Sitting through the sessions of the convention, one could not help but be impressed by the wide range of subjects that properly come under the scope of the word "concrete." Papers on nearly every phase of the subject were presented in the eight crowded sessions that comprised the program of the convention. These various subjects grouped under their general headings will be presented on the following pages.

The convention was, as usual, very business-like. More than half of the papers listed on the program were preprinted and such papers were presented in brief abstract only, leaving more time for discussion.

A "stop-and-go" signal stood on the chairman's table. When the speaker started his paper, the green light gave him the verbal right-of-way. Then, before the speaker's time was up, he was warned by the flashing of the amber light, allowing him a few minutes to finish before the red light told him that his allotted time had been used. It was almost uncanny how accurately some of the speakers gauged their time limit.

Talbot and Lord Honored

The Institute sessions started with a get-together luncheon and ended with the twenty-fourth annual dinner on the evening of March 1st.

A feature of the dinner was the special recognition given to two concretors for signal achievement in their fields. For the first time, the Henry C. Turner medal "for outstanding contributions to the knowledge of reinforced concrete design and construction," was awarded. And the award was made to a veteran in the industry, Prof. Arthur M. Talbot, of the University of Illinois, in recognition of his valuable contributions through research in concrete.

The Wasson medal for the most meritorious paper of the 1927 convention was awarded to Arthur C. Lord for his paper, "Notes on Concrete—Wacker Drive, Chicago."

Edward D. Boyer succeeded M. M. Upson as president of the Institute. S. C. Hollister was appointed vice-president to fill the vacancy following Mr. Boyer's election to the presidency. D. A. Abrams was re-elected vice-president and Harvey Whipple was re-elected secretary and treasurer.

Concrete in Architecture

Evening of February 28th Devoted to Program Having Special Architectural Appeal—Decorative Painting on Concrete Surfaces—Concrete in Monumental Types of Buildings — Reinforced Concrete Walls — Quality Concrete Needed for Architectural Uses—Concrete Economy

WHAT concrete can do and has done for the architect was the theme of a most instructive evening session of the institute. The program divided the subject into three parts, (1) decorative painting, (2) types of vaulted framing in monumental buildings, and (3) reinforced concrete walls and their surface treatment.

There were other papers presented in other sessions which also had special appeal for the architect, one on the architect's view regarding the use of concrete masonry units and another on quality of concrete with especial reference to appearance. These will be abstracted in the report of the session during which they were presented.

All of the papers were generously illustrated with stereopticon views showing beautiful architectural results secured with concrete and showing how they were obtained. In fact, the greater part of the evening was devoted to the showing of these slides and the comments regarding them.

Decorative Painting

The use of decorative painting under varying conditions was described by Sidney F. Voss, Arnold W. Brunner Associates, New York. Both examples were of large beamed ceilings, one in a mess hall at West Point, the other in an auditorium at Brooklyn. The point of difference was that the ceiling at West Point was made of a dense stone concrete, while that at Brooklyn was of cinder concrete.

These jobs represented two distinct problems and the method of treating them varied. Experiments were made with several types of cement paints and coatings in an effort to find a material that would not show discoloration because of any probable chemical reaction between the paint and the concrete as placed.

Very satisfactory results were obtained by using an undercoat of cellulose lacquer paint on the cinder concrete and covering this with top coats of lead and oil paints. No discoloration resulted. In preparing the ceiling of dense stone concrete, a solution of aluminum was used to secure a porous surface. Cellulose acetate paint was then applied to the concrete.

It was brought out in the discussion that, while decorative paints can be applied directly on concrete walls in Los Angeles, climatic and moisture conditions in the East made it necessary to use more elaborate methods in the preparation of the concrete to receive decorative paints.

Vaulted Framing

That concrete has unlimited possibilities in architecture was the opinion of Emil Praeger of B. G. Goodhue Associates, New York architects. He demonstrated some of these possibilities in a series of slides showing the use of vaulted framing in several churches built under his direction.

Mr. Praeger and his associates were the architects of the new Los Angeles city hall, a structure of monolithic concrete whose walls are of unadorned monolithic concrete. In the building of the dome, the architects used a type of reinforced concrete arch that really is not an arch at all, being two cantilever members meeting at the top. This building was constructed at a cost of only 38 cents per cubic foot. Many similar buildings cost two and three times as much.

Other interesting uses of the cantilever "arch" were illustrated in slides showing the construction of the vaulted roofs in several churches.

Reinforced Concrete Walls

W. E. Hart, of the Portland Cement Association, presented an extensively illustrated paper describing the use of concrete panel and filler walls on the Pacific Coast. In the buildings described, the use of reinforced concrete was not confined to the skeleton frame but the entire buildings, including bearing walls and filler walls, were cast as monolithic concrete structures. Rich architectural treatment was then provided as far as form or relief is concerned in the original pouring of the building and color applied later, either in paint or in stucco.

Such buildings have possibilities for beauty undreamed of in the old types. Both structurally and ornamentally they are complete concrete buildings.

Mr. Hart sounded a warning that concrete which was to be used in this manner must be of high quality because it is exposed. The old 1:2:4 concrete cannot always successfully resist exposure nor can it be decorated properly.

Such buildings meet another of the present-day requirements also—that of economy. The present tendency is toward the use of straight vertical lines—a monolith rising from the ground—and this type of building can be obtained most economically by the type described without sacrificing beauty. One item of considerable importance from an economical standpoint is the fact that ornamentation can be duplicated, i. e., that only one carved panel wall, for instance, need be modeled. Plaster of paris forms, built right in with the structural forms, will permit the casting of the ornamentation many times over, the only cost after the modeling is done being for the plaster form.

Construction Costs Increase Slightly Over 1927

Construction costs are slightly higher than they were one year ago, according to statistics just compiled by the Associated General Contractors of America. Virtually no change has been recorded since November. This is the first time in two years that a single level has been held throughout three consecutive months.

Only two changes in the average of wages paid in the construction industry have been registered since September, 1926. The most recent of these changes, recorded two months ago, was a slight decline that had no effect upon the general cost average.

"Workability"—How Is It Obtained?

Six Papers Discussing Workability of Concrete Presented in Opening Session of the A. C. I. Convention—How Can Workability Be Measured?—Cement as a Factor—Aggregates as a Factor—Water as a Factor—Workability Means Durability—What Workability Means to a Contractor

PROBABLY the most active session of the convention of the American Concrete Institute at Philadelphia centered around the subject of "workability." Everyone in the concrete industry—architect, designer, engineer, contractor, mixer man and laborer—is interested in this subject. A "workable" mix means a better looking concrete surface; filling the forms; placing around reinforcement; lower cost of placing and, as was brought out in one of the papers, greater durability.

It is an intensely practical subject and yet there are many technical aspects that must be considered.

First of all, what *is* workability? How can it be measured?

Naturally, that was the subject of the first discussion of this question. George Conahey presented a paper, "A Study of Some Methods of Measuring Workability of Concrete," prepared by him and George A. Smith and based on the experimental studies made at the U. S. Bureau of Standards in the study of Celite as an admixture.

Workability was first defined as "that property which is inversely proportional to the effort required to mix and place the concrete in order to obtain a uniform and homogeneous finished product." Consistency, it was pointed out, is an entirely different property than workability. Consistency depends only on the amount of mixing water used, whereas workability depends upon a number of facts, as will be shown.

In an effort to develop a means for evaluating or measuring workability, various types of apparatus were tried. It was the opinion of the investigators that the penetration test was the only means so far developed that has proved at all satisfactory for measuring this quality of concrete. Yet it seemed that the apparatus for making this test would need to be improved. The penetration tests as previously made used only a single rod and wide variations were found in the results of the experiments. The new apparatus, developed by the investigators, did away with the objections found in the single rod test. It consists of a three-rod plunger which was driven down into the concrete by a miniature pile driver delivering a blow of a certain measured intensity. Then the total energy required to drive the rods a certain distance into the concrete was designated as the "workability figure."

Results from the tests made with this apparatus seemed to indicate that this was the most satisfactory device yet developed for determining a workability index.

Aggregates as a Factor

With a method for measuring workability determined, the convention proceeded to study the effects of the various ingredients in concrete on workability. The gradation and character of aggregates as a factor was discussed by A. T. Goldbeck, director of the Bureau of Engineering, National Crushed Stone Association.

Mr. Goldbeck's conclusions present the gist of his researches and are given below:

"(1) When like proportions by volume are used, angular, rough aggregate makes a harsher working concrete than round, smooth aggregate due:

"a. To difference in voids and the resulting variable effect from the mortar in producing workability.

"b. To increased internal friction due to the angular shape and rough faces of the particles.

"The relative influence of these effects has not been evaluated. If like workability is to be expected from the different aggregates, the illogical method of using the same arbitrary proportions by volume should not be used. Harsher aggregates require more fine material in the mix but not necessarily more cement to produce concrete of the same workability as rounded fragments. The practice of using the same arbitrary proportions for all aggregates cannot be too strongly condemned.

"(2) A straight-line grading for the coarse aggregate extending from the maximum size to 1/10 of the maximum size provides a well-graded stone from the standpoint of

TABLE I

Crushing Strength Pounds—28 Days	Slump Inches	Maximum Size	Range of Fineness Modulus Combined Aggregates
4000	½ to 10	3	6.6 —7.0
		2	6.25—6.65
		1½	5.85—6.2
		1	5.45—5.85
		¾	5.10—5.45
3500	½ to 10	3	6.5 —6.9
		2	6.15—6.55
		1½	5.75—6.10
		1	5.40—5.75
		¾	5.00—5.35
3000	½ to 10	3	6.42—6.8
		2	6.10—6.45
		1½	5.70—6.00
		1	5.30—5.60
		¾	4.95—5.30
2500	½ to 10	3	6.35—6.7
		2	5.95—6.3
		1½	5.60—5.9
		1	5.25—5.5
		¾	4.85—5.20
2000	½ to 10	3	6.25—6.55
		2	5.85—6.20
		1½	5.50—5.80
		1	5.10—5.40
		¾	4.75—5.10
1500	½ to 10	3	6.2 —6.5
		2	5.7 —6.1
		1½	5.4 —5.7
		1	5.05—5.3
		¾	4.70—4.95

Table II

	Size of Aggregate													
Mix, Cement-Aggregate	0-No. 28	0-No. 14	0-No. 8	0-No. 4	0-No. 3*	0-⅜ in.	0-½* in.	0-¾ in.	0-1* in.	0-1½ in.	0-2.1* in.	0-3 in.	0-3½* in.	0-6 in.
1:9	1.30	1.85	2.45	3.05	3.45	3.85	4.25	4.65	5.00	5.40	5.80	6.25	6.65	7.05
1:7	1.40	1.95	2.55	3.20	3.55	3.95	4.35	4.75	5.15	5.55	5.95	6.40	6.80	7.20
1:6	1.50	2.05	2.65	3.30	3.65	4.05	4.45	4.85	5.25	5.65	6.05	6.50	6.90	7.30
1:5	1.60	2.15	2.75	3.45	3.80	4.20	4.60	5.00	5.40	5.80	6.20	6.60	7.00	7.45
1:4	1.70	2.30	2.90	3.60	4.00	4.40	4.80	5.20	5.60	6.00	6.40	6.85	7.25	7.65
1:3	1.85	2.50	3.10	3.90	4.30	4.70	5.10	5.50	5.90	6.30	6.70	7.15	7.55	8.00
1:2	2.00	2.70	3.40	4.20	4.60	5.05	5.45	5.90	6.30	6.70	7.10	7.55	7.95	8.40

*Considered as "half-size" sieves; not used in computing fineness modulus.

workability. The difficulty of using such a grading without proper precautions to prevent segregation is recognized. The gradation for given maximum sizes should be such that the fineness moduli of the combined aggregates given in Tables I or II are not exceeded.

"(3) The gradation of the fine aggregate should be as coarse as possible for economy but should not result in a fineness modulus in excess of that stated in Table II for a mortar having the same proportions as the particular concrete in which the sand is to be used."

In presenting his discussion on "The Cement Factor in Workability," Dr. P. H. Bates of the U. S. Bureau of Standards first called attention to the fact that all cements are not alike. He said that the type of cement used is a big factor in the resulting workability of the concrete. This is because of the presence in some cements of a lubricating quality varying greatly in various types.

This lubricating quality of cement can be measured, Dr. Bates pointed out, by forcing the cement paste to be tested through a cylinder with a small hole at the top. Such apparatus is called an "extrusion cylinder."

The lubricating quality of the cement is measured by the load required to press the paste through the opening at the top of the cylinder.

Another method of measuring the lubricating qualities of cements was through the use an apparatus consisting of a glass bulb at the bottom of which was a capillary tube and at the top a graduated tube. The glass bulb was filled with cement paste. Kerosene was placed in the graduated tube and its height in the tube measured at the beginning of the test. The amount of cement paste going through the bottom tube in a given time was then measured by observing the fall of the liquid in the graduated tube. This permitted the calculation of the rate of flow of cement paste which was then converted into a workability index.

It was Dr. Bates' opinion that tests such as these are of value in measuring the workability factor of the cements used.

Water as a Factor

R. L. Bertin of the White Construction Co. was assigned the subject of "Water as a Factor in Workability." This is a phase of the subject that is of particular interest to the contractor because of its practical application in the field. Mr. Bertin said:

"In order to understand clearly the effect of more or less water on concrete during the making and placing period, it is best to follow, step by step, the changes which take place in a concrete having a given proportion of dry cement, sand and stone, to which water is added gradually, from the dry state to the very wet.

"With the first increments of water, the dry mass bulks. This bulking increases to a maximum, depending on the nature of the materials used; then, as more water is added, the bulking gradually decreases until a maximum density of the mass is reached. At that point the concrete becomes plastic. The addition of more water causes the mass again to increase in volume until a point is reached when segregation takes place because of the dilution of the mixture.

"The minimum amount of water which should be used is that which will overcome the bulking of the mass; and the maximum, that which will produce concrete of the required strength and density and which will not start segregation. These maxima and minima vary with the nature of the materials used and their proportions and the required strength and density of the finished concrete.

"The limitations of water content mentioned are the ones within which workability may be varied with the use of more or less water. If proper workability cannot be obtained within these limits, the concrete proportions or materials must be changed."

Relation of Workability and Durability

There is a very definite relation between the workability and durability of concrete, according to R. W. Atwater of McClellan and Junkersfeld, who presented the next paper on "Workability Means Durability to the Engineer." In fact, he says definitely that "workability is the measure which can now best be applied in the manufacture of concrete to predetermine the quality of the resulting material."

If the aggregates are clean and sound, and the cement of suitable quality, the strength of the concrete can be controlled by the water-cement ratio *provided the mix is workable.* Workability, being of such importance, should be insisted upon by engineers in charge of concrete construction. Contractors who have been in the habit of handling concrete through long lines of chutes from a single setup are sometimes likely to complain that the correct degree of workability is expensive to handle. Mr. Atwater thinks, on the contrary, that experience has shown that, when the concrete is mixed to the plasticity which gives minimum segregation, it flows readily and can easily be puddled into all corners and around the reinforcing steel.

Speaking of admixtures, Mr. Atwater says: "Admixtures undoubtedly have a place in the manufacture of concrete and can be advantageously used under certain conditions."

What Workability Means to the Contractor

In the previous discussions all the various factors influencing workability have been examined. They have a practical application as was brought out in the previous paper. But what does the contractor think about workability? Is it practical from *his* point of view?

In a paper, printed in full with the permission of the Institute on other pages of this issue, Nelson L. Doe, general superintendent of the Turner Construction Company and a practical contractor, tells his side of the story.

Workability Discussion

Discussion of all papers was postponed until they had been read. Then the general subject of workability was thrown open for remarks and questions. The volume and spirit of the discussions on this subject evidenced the interest it held.

John A. Ahlers presented a written discussion bringing out the effect of the water-cement paste on workability. This can be added to the mix in quantities as needed to secure the workability decided upon. Mr. Ahlers' experiments showed that dehydrated cement, used as a slurry, will usually result in greater workability without increasing the cost, sometimes even effecting savings up to $1.00 per cubic yard of concrete.

There was considerable difference of opinion as to whether or not such care to secure workability was not "babying" the laborer too much. Another necessary factor in good concrete was "ability to work," one that is often neglected. It was pointed out that sometimes greater overall economy is secured when a less workable mix is used and the savings in materials more than overbalance the greater cost of placing.

Crazing—One of the Subjects Discussed in Research Session

Research Session of A. C. I. Program Covers Many Problems—Crazing Studies Arouse Interest—Predicting Concrete Strength — Carrying Capacity of Semi-Circular Hooks — Arch Dam Investigations — Concrete Flow Under Sustained Pressure—Committee Reports

THE great number of problems confronting the concrete industry are fairly indicated by the many phases of the subject brought forward during the Wednesday morning session of the Institute, which was devoted to concrete research.

The vast amount of research now under way is shown forcibly in the report of Committee E-3 on Research. There is a consistent demand for better concrete which calls for more and still more practical information that must first be developed in the laboratory. Throughout the convention the desire to learn more of this many-sided subject was strikingly evident. Better concrete was the quest and it was clear that entire satisfaction had not yet been attained in the matter of concrete quality.

Crazing

The question of crazing is still with us and the magic formula that will eliminate it once and for all time has not yet been found. Some producers of cast stone feel that they have taken steps to eliminate at least the appearance of crazing, only to find it cropping up again in the most unexpected manner. Architects are not agreed as to whether crazing constitutes a disfigurement or is of little moment.

What causes crazing seems to be pretty well known and agreed upon by the men who discussed the subject. But what is the precise method to use in its control is still frankly unknown. Interesting facts affecting crazing were brought out in the papers presented but in each case the conclusion was "We know what causes crazing but we can't prevent it under all conditions."

P. H. Bates and C. H. Jumper of the U. S. Bureau of Standards reported the progress being made on some studies of crazing of portland cement mortars or stuccos. This study has been in progress at the U. S. Bureau of Standards for several years. A large number of differing types of stucco mixes were used. The aim was to cover the sand area completely with a layer of cement. The mortars were applied to three different bases—glass, thin rubber sheeting, and a well hardened cement mortar so that comparisons could be made between absorptive and non-absorptive bases and between bases whose areas change greatly.

These specimens were stored under varying conditions. Some of the specimens were subject to a draft produced by an electric fan immediately after they were made. It was found that this did not increase crazing. Prof. Hatt, of Purdue University, in discussing the paper, said that he had had the same experience as Dr. Bates when warm air was blown over the specimens. Others were wetted down after hardening and still others were exposed to outside atmospheric conditions. At intervals their condition was noted.

Dr. Bates' conclusion is that "It is confessed that so far, after a year and a half of work, nothing very tangible for solving the problem of crazing has been obtained. On the other hand apparently an estimate of the magnitude of the effect of some of the several variables, particularly humidity and temperature, in causing this annoyance is being obtained. This is of much importance and will assist materially in leading the present and future work more directly toward solving the crazing problem." He also pointed out that two variables affecting crazing are the brand of cement used and the workmanship.

Prof. White's Studies

Proceeding independently and from another point of view, Prof. Alfred H. White, of the University of Michigan, made studies which were reported by him in a paper, "Crazing in Concrete and the Growth of Hair Cracks Into Structural Cracks." He attacked the problem from the standpoint of the colloidal properties of hydrated portland cement and the internal stresses generated in concrete by alternate wetting and drying. When water starts to evaporate from a surface of wet concrete, the surface tries to contract but is restrained by the swollen material below it. The bottom layers of the concrete are therefore in compression and the top layers in tension. Then, since concrete is stronger in compression than in tension, there will be a tendency for cracks to form on the surface, which is in tension.

Prof. White's conclusions are of value:

"Crazing is due mainly to the rather rapid evaporation of water from the surface of a rich cement mortar or concrete. The surface becomes dry and tries to contract but is restrained by the main body of the material which is still wet and swollen. The surface is thus put into tension and hair cracks form. The colloid of cement requires many months in water for its full development and the magnitude of the stresses, caused by alternations of wet and dry conditions, increases with the amount of colloid developed. The fact that hair cracks cannot be detected after the first alternation between the wet and dry state does not indicate that they may not be formed later. The same forces which cause hair cracks to form are also adequate to make them larger and deeper so that hair cracks may ultimately become structural cracks.

Crazing may be prevented by using lean mixtures, and by keeping the moisture content of the concrete constant. It is immaterial whether the concrete is wet or dry so long as the moisture is constant. Protective coatings and integral waterproofings of the water-repellent type are helpful. If integral waterproofings are used, care must be taken to keep the concrete damp until adequate strength is obtained, for after such waterproofed material has once become dry, it will absorb water only slowly."

Predicting Concrete Strength

We have made some progress in controlling and predetermining the strength of concrete, yet there are often wide variations in strength under actual job conditions. "Viewed dispassionately," says Prof. H. J. Gilkey, in presenting his paper describing a method for predicting concrete strengths, "if 2,000 lb. concrete has been selected as the needed mixture, 1,000 lb. concrete is a hazard and 3,000 lb. concrete an extravagance."

Prof. Gilkey has proceeded on the basis that quality control can be made much more valuable if all the "systematic" factors, such as water-cement ratio, period of moist curing, curing temperatures, time of mixing, etc., as found in a definite condition are compared with known results under parallel conditions. Knowing the strength that a given cement and aggregate give under any one set of systematic conditions, it should be possible to predict with reasonable accuracy the strength that the same cement and aggregate will give for any other known or assumed combination of systematic factors.

Testing Concrete in the Field

C. A. Wiepking, testing engineer, Department of Public Works, Milwaukee, presented a paper describing his studies to determine whether or not a 4- by 6- by 24-inch beam could not be used for field tests of concrete instead of the larger and heavier 6- by 8- by 30-inch beam now used. The smaller beam weighs only 50 pounds while the larger beam weighs 125 pounds.

Mr. Wiepking found that the 4- by 6- by 24-inch beam can be used effectively for testing concrete of a workable consistency when the maximum size of the aggregate used did not exceed 1½ inches. For larger aggregates a correspondingly larger beam should be used, but always with greater depth than width so that the concrete will have enough bulk to puddle easily.

Semi-Circular Hooks

"The Carrying Capacity of Semi-Circular Hooks," was the title of a paper presented by T. D. Mylrea of the Carnegie Institute of Technology. In this paper, Prof. Mylrea presented the results of a series of tests made under his direction, in which semi-circular hooks ranging from 1d (flat bend) to 12d, reinforced with spiraling up to 10 turns of ¼ inch round wire, were tested. His conclusions were: (a) that flat bends, spiraled or unspiraled, do not form a satisfactory anchorage. No flat bend developed the elastic limit of the steel; (b) increasing the diameter of the hook increases the load carrying capacity, and spiraled hooks showed greatest strength; (c) slip was evident at the point of tangency for very low loads and movement of the whole bar at loads far below the ultimate strength developed.

Arch Dam Investigation

W. A. Slater of the U. S. Bureau of Standards presented a most interesting account of the investigations made under his direction at the Stevenson Creek Dam near Fresno, Calif. Stereopticon slides showing the locations of the measuring stations and the equipment used were shown and explained.

Strain gauges and telemeters were used to obtain stress measurements at a great many places on the dam and when the final results from both sets of instruments were secured, very good agreement was shown. Specially designed electrical micrometers were used to measure the width of cracks under water.

Analysis of the data secured indicated that for design purposes, it was possible to assume a dam as divided into horizontal and vertical sections. The total load, as determined by the investigators, was found to be very nearly the calculated load. This indicates that the methods used to compute the stresses can be used in designing similar structures.

It was found that there was a penetration of only 2 inches of water after the dam had been under a pressure of 150 pounds for two weeks. An interesting point in the making of concrete as impervious as this was the fact that a large proportion of fine aggregate was used, of which approximately 26 per cent passed the 100-mesh sieve.

Flow of Concrete Under Sustained Compressive Stress

Two series of tests, extending over a period of two years, in which concrete cylinders were subjected to a constant sustained stress by means of car springs, were reported by Prof. R. E. Davis of the University of California. The object of the tests was to determine the "flow" or plastic deformation of the cylinders under loadings of from 200 to 1,200 pounds per square inch.

Most of the specimens under test are still shortening, except those which have been kept under a spray of water. This ability to flow, says Prof. Davis, is fortunate because it permits a redistribution or trend toward equalization of stresses over a long period of time.

Some of the conclusions are: That the leaner the mix, the greater the flow; that the smaller the fineness modulus, the greater the flow; that the flow of concrete stored in air is greater than that of concrete stored under a water spray; that the higher the sustained stress, the more rapid the flow.

Committee Reports

During this session the reports of Committee E-3 on research and Committee E-5 on aggregates were submitted.

Committee E-3, in its report, presented a detailed summary of the research work now in progress in the various laboratories and an index of the articles published during the past year on technical subjects relating to concrete.

Committee E-5 reported progress in formulating a method of test for abrasion of gravel. The tentative purchase specifications for concrete aggregates adopted by the Institute in 1926 were still incomplete. A supplementary report, presenting revised specifications for quantitative determination of deleterious materials in aggregates was adopted.

Concrete Products Problems Formed Basis of Two A. C. I. Sessions

Concrete Building Units and Cast Stone Receive Much Attention at A. C. I. Convention—Roofing Tile Problems—Viewpoint of the Architect on Concrete Masonry Units—Specifications for Cast Stone—Building Codes—Light-Weight Aggregate—Shrinkage of Concrete Brick—Report of Committee P-1

MANY phases of concrete products manufacture and merchandising were given place on the program of the A. C. I. convention. Two entire sessions were devoted to these discussions and in addition there were meetings of the National Concrete Products Association and the cast stone manufacturers independently of the A. C. I. programs. These are reported on other papers in this issue.

An event of considerable importance to the concrete products industry was the discussion that followed the presentation of two papers outlining the need for standard specifications for cast stone. One of these was C. Van de Bogart's paper on "Specifications for Concrete Stone," which was published in full in the March issue. The other was a paper by M. A. Arnold of Jacksonville, entitled "The Need of a National Certification Plan."

Mr. Arnold's paper followed very closely the recommendations made in Mr. Van de Bogart's paper that some action be taken to prepare standard specifications for cast stone. He deplored the tendency of some manufacturers to consider their processes "secret." There are no secrets. Any manufacturer can get results identical with stone produced by any other manufacturer.

An item of importance was the selection of the correct name for cast stone. There are now too many names used—cast stone, concrete stone, artificial stone, synthetic stone, etc.

Much research work will be necessary before proper specifications can be formulated and Mr. Arnold proposed that a committee consisting of producers, architects and independent engineers be formed to study the subject.

The discussion that followed these pleas for standard specifications brought out the wide variation in architects' methods of specifying cast stone. One manufacturer recommended that the specifications need only refer to a "standard sample" of cast stone which has been selected by the architect.

The immediate result of the discussion was the passing of a motion authorizing the Board of Governors of the Institute to appoint a committee on cast stone specifications.

The Architect's Viewpoint

That the architect in general has "not been so hot" for the use of concrete products was brought out in a paper by G. J. Eyrick, Jr., of Smith, Hinchman & Grylls, Detroit architects.

But, he said, this is an age of synthesis. Synthetic products are being made and used in every phase of our lives and concrete products are synthetic products. You break down rock and recombine them to make concrete stone. The important thing is that the architect must know that it is a *synthetic* product and *not an imitation.*

Mr. Eyrick also approached the subject of standard specifications from the architect's point of view. How can the architect specify cast stone with assurance that he is going to get a quality product when there are no standard specifications and tests, he asked. Such standard specifications will be a great relief to the architect and will help gain his good will.

In discussing concrete block from the point of view of the architect, two features were mentioned—weight and appearance. It was pointed out that the weight of a building unit is an important factor in the cost of the wall. An increase in weight causes an increase in cost which is often greater than the savings made in the cost of the product itself. Light-weight aggregates will do much to overcome this objection.

The appearance of concrete block is against the use of it for architectural purposes, especially rock faced block. Often the block manufacturer is careless in delivering the block with the result that corners and edges are broken—a point of importance to the architect.

Roofing Tile

Concrete roofing tile problems were discussed by L. H Allen of the Hawthorne Roofing Tile Company of New York. Color is the principal problem of the concrete roofing tile manufacturer. So important is it, that the differences in tile can be measured by the quality of the color.

The need for using proper pigments was stressed. Cheap colors of an inferior quality have done much to retard the progress of the industry. Enough color cannot be used in the body of the tile to give it the tints and luster necessary; neither can the color be satisfactorily dusted on the surface and trowelled in. The most successful procedure is to mix the color with cement and fine sand in a mixer, add water and apply it to the tile.

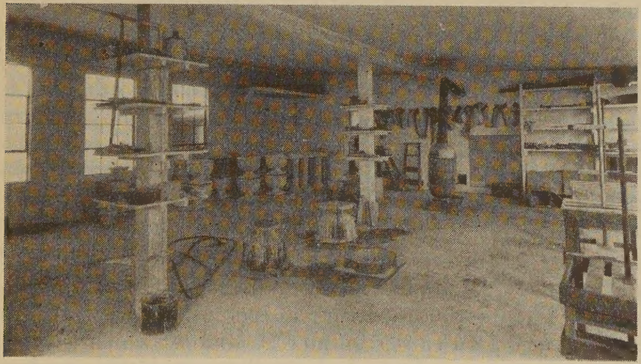
Pigments must be selected that will not react with the cement, as this causes discoloration. Efflorescence is a serious problem, usually due to the soluble alkalis in the concrete. Mr. Allen has found that proper curing helps to reduce efflorescence because it prevents surface evaporation until the tile has hardened. He also found that the denser the surface of the tile, the less the tendency toward efflorescence.

A practical help given was the warning not to use crude oil on the pallets. It causes stains. A satisfactory material for oiling pallets has been found in a mixture of animal tallow and kerosene.

In speaking of coloring pigments, Mr. Allen warned against the use of lamp black and this warning was later emphasized by Dr. Maxmillian Toch. Lamp black contains oil as a result of its method of manufacture. Carbon black, however, made from natural gas, has been found satisfactory.

Better Stucco

W. S. Steele, of the Mohawk Stucco Co., Brooklyn, N. Y., made a forceful plea for improving the general quality of the portland cement stucco used. Comparatively little is known about what constitutes quality stucco and how its merits can be measured. Here is a field for needed research. The minimum tensile strength requirement for stucco should be determined. A method for measuring the most favorable degree of plasticity is needed. Injurious and beneficial admixtures should be determined and made known. Studies on the effect of color pigments would be of value.



Display room in a products and cast stone plant

In short, the portland cement stucco industry also needs a standard specification. Then simple and complete instructions should be compiled and distributed with the object of improving stucco quality generally. Some interesting facts regarding the great variety in stuccos was brought out in the discussion. All sorts of admixtures were found—lime up to 70 per cent, marble dust up to 100 per cent by weight of the cement, etc. There were variations in the strengths of prepared stuccos and in absorption tests.

Building Codes

"Spec" Collins is developing a well deserved reputation as an expert on building codes and their relation to the concrete products industry. At every opportunity he points out to products manufacturers how they can use fair building codes as an aid in merchandising.

That was the theme of his paper at the second products session of the A. C. I. He recounted the methods used to secure a favorable state building law, how it affected the quality of concrete block in Wisconsin and then how the manufacturer used the building code as a sales aid.

Light-Weight Aggregate

A. W. Scheer's paper on his experiences in making haydite block provoked some profitable discussion which indicated the interest in this subject of light-weight aggregates. It indicated that the industry was getting down to a study of the structure of aggregates and its effect on block manufacture and quality.

Here, too, the point was brought out that compressive strength is not the only quality required in concrete block. Light weight and absorption were of equal importance. It was recommended that serious consideration be given the problem of devising a method for determining porosity.

Freezing and thawing tests of light-weight aggregate block were discussed by C. A. Wiepking and by E. Christensen of the National Building Units Corp. Both reported increases in the strength of the units after they had been subjected to freezing and thawing tests.

Shrinkage of Concrete Brick

Les Grube, of Sheboygan, explained the methods used to dry out concrete brick in his plant after they had passed the wet curing period and before they were taken out of the yard. His paper described the experiments made at his plant in Sheboygan.

It was found that the concrete brick made at the plant dried out satisfactorily in the stockpiles during warm weather, but that difficulties were experienced when the outside temperatures dropped to 50 degrees and below.

Sveral methods were experimented with and the method now being used is yielding very satisfactory results. It is as follows: A unit-heater, similar in appearance to an automobile radiator, was secured. The heater used is about 3 0inches square and about 10 inches thick, having horizontal copper tubes. Steam is admitted to the heater at the top and the condensation is drained at the bottom through a Dunham trap and returned to the boiler. It can deliver 500 square feet of radiation.

Report of Committee P-1

In addition to several suggestions regarding specifications for concrete masonry units, the report of Committee P-1 on standard concrete building units included a statement of the preliminary investigation of methods of tamping and feeding concrete for dry tamped products.

The committee reported against the advancement of the concrete brick specifications from tentative to standard specifications pending an attempt to correlate the A. S. T. M. specifications and the A. C. I. specifications. The committee also recommended that the specifications for manhole block be advanced from tentative to standard specifications with a change in title from specifications for Manhole and Catch Basin Block to Specifications for Sewer Manhole and Catch Basin Block. This recommendation was defeated and the specifications were continued as tentative with the change in the title as suggested.

American Concrete Institute Adopts New Concrete Code

New Concrete Code Adopted at A. C. I. Convention Points Way to Construction Economies—Design and Cost Data for New Code Presented—Skew Arch Design —Calculation of Flat Plates by the Elastic Web Method

A NEW set of regulations covering reinforced concrete design and construction was adopted by the American Concrete Institute during an evening session lasting until well after midnight. The adoption of this new code is of far-reaching importance to the concrete industry as a whole and points the way to important possible economies in concrete construction. Its preparation and presentation mark one of the high points in the work of the Institute.

The code as presented is suitable for direct incorporation in building codes and already at least one city building code has been revised to incorporate some of the new code's advanced features. The Proposed Standard Building Regulations for Reinforced Concrete, as it is called, is the report of Committee E-1 of which F. R. McMillan is chairman. It was prepared jointly by this committee and the committee on engineering practice of the Concrete Reinforcing Steel Institute. The present draft is the result of several years' work. It takes into account the recent advances in concrete practice; in fact, it is because of the progress made in controlling the quality of concrete and its manipulation that the revisions were made possible.

New Code Provisions

A number of important changes were made and incorporated in the new code. Among them are:

(1) An increase in the unit tensile stresses in intermediate grade billet-steel reinforcing bars and in rail steel reinforcing bars from 18,000 pounds to 20,000 pounds per square inch, while the stress in all web reinforcement has been decreased to 16,000 pounds per square inch.

(2) The discrimination in the 1927 report against the use of rail steel reinforcement has been removed.

(3) The method of specifying concrete has been changed so as to include a provision for the use of concrete with strength in excess of 3,000 pounds per square inch where very rigid control is assured.

(4) The maximum permissible shearing stress on concrete beams has been reduced from 0.12 of the crushing strength to 0.09 except under some special conditions.

In a lengthy discussion of the report a number of additional revisions were suggested. These were with regard to details such as the advisability of a more precise differentiation of "composite" and "combination" columns; a change in field test requirements which included the use of a set of specimens cured in the laboratories as a check on mix control and another set cured in the field as a check on curing. Section by section, the code was presented and discussed, finally being approved as a whole as a tentative standard. The proposed last minute revisions were referred to the committee to be reported upon at the next convention.

Design and Cost Data

Another important paper, closely related to the code, was presented by A. R. Lord, consulting engineer of Chicago, under the title, "Design and Cost Data for the 1928 Joint Standard Building Code." This paper, comprising 115 pages of printed matter, represents a tremendous amount of work—probably the longest paper ever presented to the Institute.

1928 Code

Mr. Lord's paper presents design tables and diagrams based on the 1928 code and thus overcomes one objection to the use of the new code. When an old code is abandoned the usefulness of the old design tables and charts, often requiring a great deal of time in their preparation, is lost. Mr. Lord, in his paper, presents engineers with the new tools needed to apply the new building code.

The paper includes tables and diagrams for designing beams, columns, slabs and footings using the new requirements adopted at the convention. With these tables and diagrams as a foundation, a study has been made of the comparative costs of structures using 2,000-pound concrete and of identical structures using concrete of considerably higher ultimate strength. This study indicates that a considerable direct saving in cost can be made in addition to securing a higher quality of concrete from the standpoint of durability when the higher strength concretes are used.

Skew Arches

The building of an unusual skew arch bridge was described from the standpoint of its design, its construction and an analysis of its stresses in a paper on "Skew Arch Design and Construction," presented by S. C. Hollister, of Philadelphia. The bridge described is the West Ninth St. bridge at Chester, Pa. It has a span of 160 feet, a ratio of rise to span of over one to thirteen, a 60-foot width and a 42 degree skew. No part of either abutment face is perpendicularly opposite the other. It is tubular in cross-section.

The paper describes in detail the preliminary analysis, the design, the construction and the extensometer measurements taken during construction and after the bridge was completed.

Concrete Slab Design

The "elastic web" method of slab analysis used by Dr. H. Marcus, of Breslau, Germany, was described in a paper by J. A. Wise, of the University of Minnesota. This is the first time, to the writer's knowledge, that this method has been made available in English engineering literature.

The basic principles involved are explained after which their application to the solution of square, rectangular, triangular and circular plates is illustrated.

Better Concrete—Do We Mean It?

Last Session of A. C. I. Convention Devoted to a Discussion of Field Problems in Concrete Construction — Better Concrete — Heavy Duty Concrete Floors — Strength Specification—A Concrete Primer

HERE, in the last session of the convention of the American Concrete Institute, the discussion again turned emphatically to the central theme of the entire convention—better concrete. And again the question, "Do we mean it?" was asked. Better concrete must be sought from every point of view and many factors influencing the quality of concrete came up for review.

"The concrete industry in the United States calls for the annual expenditure of approximately two billions of dollars," said Nathan C. Johnson, New York consulting engineer. "Yet, if a better understanding were had of the innate and intrinsic virtues and abilities of concrete, *four* billions of dollars would not be a fanciful dream for the 1930 expenditures."

"But," pointed out Mr. Johnson, "we must get a new viewpoint of what 'quality' really means. Too long we have been worshipping at the shrine of compressive strength; other qualities are of equal if not greater importance. What has compressive strength to do with endurance under exposure? We must face this problem of durability frankly. How shall we as engineers or you as contractors or owners know of a surety that the qualities necessary for endurance are embodied in the structure?" he asked.

So the "audit" of the present status of the art of making concrete was continued, always with the future welfare of the industry in mind. We must learn to utilize the inherent properties of concrete better than we do now and this will be the basis upon which the future progress of the industry can be gauged. Beauty and durability requirements can be met by refinements which must come.

"Progress is with us," concluded Mr. Johnson, "but the grand total of progress will, among other things, require the laying aside of old jealousies, old dicta, and old prejudices, with a joining together of all along broad lines and to an even greater benefit of all mankind."

A spirited discussion followed in which others voiced the thought that the real objective in making concrete is not strength alone, but all-around serviceability. The suggestion was made that a committee be appointed whose duty it would be to study the possibilities of beauty in concrete from an architectural point of view.

Concrete Primer

Another paper dealing with the fundamentals of good concrete is the "Concrete Primer," prepared and presented by F. R. McMillan. This paper is intended for wide circulation in an effort to make the factors which control the quality of concrete known to a greater number.

The booklet consists of about 100 questions and answers, worded as simply and as concisely as possible. They cover, in a novel manner, the things known today about concrete.

Experience with a Strength Specification Contract

This paper, presented by R. C. Johnson, of the Immel Construction Co., Fond du Lac, Wis., was published in full in the March issue of CONCRETE. It tells in detail the experience of the Immel Construction Co. on a large concrete job placed under strength specifications and presents the contractor's viewpoint on quality controlled concrete.

Heavy Duty Concrete Floors

Another paper dealing with quality of concrete from a different viewpoint was presented under the above title by C. E. Covell of the Austin Company. He discussed the problem of constructing concrete floor surfaces that will not dust or show undue wear under modern industrial uses.

A good concrete floor must embody two essential characteristics: (1) strength to resist compression and shear in the slab due to static loads and to the concentrated wheel loads of moving trucks, (2) resistance to surface wear and dusting due to impact and the abrasion and crushing of the surface particles caused by truck wheels and loads dragged over the surface. The first of these requirements is easily attained through design; the second is more difficult to secure even when great care is used.

Wide experience in building floors of this type enabled the author to lay down certain requirements that have proved beneficial. Some of them are:

Concrete should be of such a consistency that screeding and floating are required to bring water to the surface.

Concrete must be mixed at least 1¼ minutes, or longer, if possible.

Properly graded aggregates are necessary. Flat, elongated particles may cause pitting.

Fine aggregate, especially, must be tested for organic impurities.

Only trained, experienced men are to be used to do the floor finishing.

Floors should be trowelled as little as possible.

No "dryer" should be used in surface finishing.

At least 10 days must be allowed to *water*-cure the floor before grinding it.

The top surface of the floor must be of a richer mix than 1:2:3½.

The use of a smaller maximum size of aggregate in the top will give the floor a more uniform appearance.

Road Specification Revisions

Committee S-6 on concrete roads and pavements submitted some proposed revisions in the Standard Specifications for One Course Portland Cement Pavement. Since this is the master specification for the pavement series, it affects the street and road specifications also.

The recommendations included a change to the effect that coarse aggregate, excepting air-cooled blast furnace slag, shall show not more than 5 per cent loss in the wear test. Other revisions dealt with the specification for joint fillers and the sentence referring to the use of Abrams' Table of Proportions and Quantities for Concrete Road Construction was omitted from the reference note.

"Big Business" Is Theme at Concrete Products Association Convention

Day and a Half Session of National Concrete Products Association Precedes A. C. I. Meeting—Merchandising and Advertising Are Big Items on Program—Review of Past Developments and Forecast of Future Tendencies

THERE are two main divisions of any convention. One is what happens and what is talked about on the floor in the formal sessions. The other is the undercurrent that manifests itself only in private or small group conversations and in the rooms between and after the formal sessions.

At the convention of the National Concrete Products Association in Philadelphia, February 27th and 28th, these two divisions were very noticeable. On the convention floor, the main theme was the search for knowledge on merchandising and advertising matters. There was a distinct feeling that the industry was thinking in terms of "big business." In the room and group conversations, this theme was also discussed, but there was, in addition, much conversation on the subject of light-weight aggregates, both of the burnt clay and cinder type. While the concrete products convention was under way, several auxiliary groups, whose interests centered around cinder block, met.

The convention was a serious one. All these men were facing very real problems that affected their industry both internally and from outside sources. They came to the convention to thrash these out. An important step taken was the appointment of a full time, paid executive secretary and a reorganization of the work of the association on that basis. F. O. Matthiessen of Philadelphia was employed to fill this office. He will work toward increasing the membership of the organization and will co-ordinate the many activities undertaken by the association. A program of future activities was discussed to the end that more definite results will be accomplished.

The address of the retiring president, Sidney I. Crew, summarized the present problems of the industry and pointed out some possible future developments. It is presented below.

President's Address

"We are now crossing the threshold of the most promising era in the history of the products industry. Each year that we have met together as state associations and a national organization has been a step forward. A new importance in the building industry has come to our product. But I am convinced that we now stand at the beginning of a period of recognition never attained before.

"As I look back over the early history of our business, with its hand molds and backyard methods, I cannot help but marvel at the change that has come over the industry. It is simply the survival of the fittest. If it had been possible to have gotten together a gathering of this sort in those days, we might have hesitated to invite guests of prominence, feeling that they would not be favorably impressed. In contrast it would be hard to distinguish our present gathering from one of bankers or professional men. This fact alone is a symbol of what has taken place in the industry. Each year sees men of more ability in our ranks, thus putting the concrete masonry unit on a constantly rising plane.

"The day is not far past when the quality of a concrete unit was an unknown variable. We are still faced in some instances with intense prejudice on that account. However, due to increased knowledge in methods of manufacture and the research work of such organizations as the Portland Cement Association, the American Concrete Institute, and other similar research bodies, I believe we are successfully passing that stage. Concrete units of poor quality today are more unusual than usual. In my own state of Ohio, we are now operating under a quality standard that requires our product to withstand 1000 lbs. per square inch over the gross area. This is not only met with ease but exceeded economically where proper methods of manufacture are used.

"Wherever a building ordinance has recognized our product and called for a high standard of quality, it has invariably worked for the benefit of the industry. Products production increased in Cincinnati more than 400 per cent since our ordinance went into effect about four years ago, while a greater change has taken place in the esteem in which our product is held.

"Formerly concrete units were thought of as a poor grade of building material with a reputation for being weak, damp and cheap. Now they are classed as a high grade building material to be used interchangeably with clay brick and *wherever* these may be used in the city. However, we cannot rest on the oars in our relations with our building officials. Already in Cincinnati, forces are at work to topple concrete products from the high pedestal they have gained. New building commissioners come in. New codes are written, and the price of continued recognition is eternal vigilance.

"With our business removed from the class of small manufacture to that of *big business* by reason of quantity production, improved machinery and methods, we shall be able to utilize every resource to further this end and to educate the public to the increased use of our product.

"Methods of merchandising are changing. We cannot wait now as we did in the past for orders to come to us. Each building project, as it comes up, will be watched and analyzed for a possible use of our product. The successful manufacturer will employ salesmen of ability and energy to do these things that we have neglected to do in the past. We shall use the medium of advertising to its fullest extent. In other words, if we are to be *big business*, we shall have to use all of the methods that the words imply.

"For the future, I see for us success undreamed of before, not however in the continuation of our present unsatisfactory policies, but in the ways I have outlined here. May this coming year realize for all of us that full measure of accomplishment and progress which our industry deserves."

Past and Future of Concrete Products

A very complete analysis of the past year and the tendencies it indicates was presented by Bill Allan of the Portland Cement Association. He began with an analysis of the 1927 production of concrete masonry units, bringing out the fact that in the past year 28 plants produced the equivalent of 1,000,000 8- by 8- by 16-inch units or more. This, in contrast to the situation six years ago when not more than one plant could enter this class, indicates one phase of the trend toward the entry of the concrete products industry into big business. This trend was probably responsible for the high rate of mortality among the small plants during the past year and is a favorable sign, for the small inefficient plant is no longer able to compete against the large, well organized and well financed aggressive manufacturer.

Mr. Allan emphasized the advantages that followed the almost universal increase in the quality of concrete products and the beneficial results that followed the certification plan of the Underwriters' Laboratories.

Another item influencing progress was the increasing knowledge of operating methods and their effect on the quality and cost of the products. Much research work has been done on many phases of concrete block manufacture and the data so gained has been of great value to the industry.

A warning was sounded on the subject of "red ink expansion"—the tendency to overinvest in plant equipment. "A large, over-equipped plant may be of interest to visitors," Mr. Allan said, "but whether or not it is a satisfactory plant depends on the amount of profit it is earning for the manufacturer. In general, the profit will be largest in the plant that has kept the fixed capital down as low as possible and that operates machinery so as to secure the greatest production from it."

The third point emphasized was the need for aggressive merchandising and all that that implies. "There are now 4200 concrete products plants in the United States making an average of 84,000 concrete block a year. If the thousand leading plants would aggressively market their products, the industry would soon be producing a billion block per year. This is the figure he set for 1935.

Advertising Concrete Products

The subject of advertising as an aid to sales was first discussed by Newton D. Benson of Providence, R. I. His paper, published on another page in this issue was followed by a talk on the "Value of National Advertising," given by I. D. Carson of the Philadelphia office of N. W. Ayer & Sons.

Mr. Carson spoke of the "new competition" and outlined the relationship of advertising to business. There are changing times and the industry that watches trends carefully can usually modify its product or methods so as to be abreast of the times.

As evidences of the beneficial effects of national advertising campaigns, Major Carson exhibited charts showing the increase in business that followed the advertising campaigns of various associations representing types of building materials.

Another point touched on was the steadily increasing number of buyers coming into the market for building materials. The 660,000 weddings taking place annually extends the market for home building materials every year. Saturation is a long way off, if, indeed, it exists at all.

Block Plant Mergers

Another evidence of the big business trend of the industry is the tendency toward consolidations of concrete products plants. Why such consolidations are advantageous was pointed out by C. J. Herzog, of the Consolidated Concrete Products Co., Pittsburgh. Mr. Herzog said, in part:

"The advent of the more or less automatic machinery requiring larger investments and railroad sites was a step forward for the industry. This did much to put the business on a firmer foundation. It attracted a better type of individual and the block industry began to be recognized as a real business.

"Following the war many of the larger type of plants just mentioned were built to take care of the abnormal building demand. When the unusual tonnage was decreased, the result was an over-productive capacity. These conditions as outlined represent in a general way what has happened in nearly every locality.

"The writer will attempt to outline the Pittsburgh situation from here with the thought that it may help manufacturers in other localities. With this over-productive capacity and large capital investments the inevitable happened, namely, cut throat competition. However, in the face of such conditions one fact stood out sharply, and that was that the concrete products business was fast becoming a basic industry with great possibilities if properly financed and managed.

"With this idea in mind it was finally agreed to merge four of the larger plants located in the north, south, east and west districts of the city with sufficient financing to assure the success of the whole proposition. Many problems immediately arose. It was necessary to weld into one loyal organization what had formerly been four competing groups. Each individual must find his niche. A complete reorganization must be effected and, of course, some must be eliminated entirely, as one of the reasons for the merger was to lower the overhead. These and many other problems have been worked out fairly successfully during the past year.

"It may be well to mention some of the many advantages that this merger has made possible,

"(1) A centralized sales office and display rooms for the various products manufactured.

"(2) A considerable saving in overhead expense as compared with that of four separate companies.

"(3) An average reduction in hauling expense due to the advantageous location of the plants.

"(4) A saving in the purchase of raw materials has been effected because of the much larger buying power.

"(5) The new company has very much better control of the credit and collection situation than did any of the individual companies.

"(6) Due to the better standing of the larger company it has been possible to correct some of the evils of the business as previously mentioned.

"(7) One of the most valuable things done by the company was the establishment of an engineering and research department. This department has done some very excellent work in reducing the weight of the standard units, thus effecting a considerable saving in material costs. A study of all available aggregates is being made which promises some further saving in raw material costs. This department has also developed some new reinforced units, one of which has already been accepted by the trade as a recognized concrete product. The unit referred to is a reinforced concrete floor slab, which is made 12 inches in width and any length up to 10 feet. Some 200 contractors are regular users of this unit for porch floors. It has been passed by the city building department and several installations have been made in the business district of Pittsburgh on remodeling jobs and for flat roof construction.

"(8) An intangible, but nevertheless, real benefit of the merger is the added influence and standing given the business as a whole by the men who made it financially possible.

"(9) The diversified line of concrete products manufactured and about to be manufactured gives the company a distinct advantage over its competitors. Whenever possible the newly developed products are being covered by patents and in the near future the manufacturing rights will be licensed to similar companies in other cities.

"The company is now manufacturing concrete blocks, concrete tile, concrete roofing tile in French, English and Spanish models, roof and floor slabs, California portland cement stucco and interior decorative plaster, and ornamental trimstone as well as colored concrete units. Within the next two months the company will add to its line cinder blocks and partition slabs.

"In conclusion, I would say that the concrete products home or even larger building is no longer a dream, but can be made a reality any day. For with a concrete block foundation, walls of concrete blocks and tile covered with California stucco on the outside and colored plaster on the inside, concrete floor slabs for the floors and roofs, concrete partition blocks, concrete ornamental trimstone and concrete roof tile, a building can be erected that is not only economical, but fireproof and decorative. When the facts become more generally known by the public no right thinking man will allow his family to go to sleep in the fire-traps that we now call homes."

What of the Future?

An analysis of the future of the industry, especially as it is bound up with the National Concrete Products Association was the concluding paper in the separate program of the association.

In this paper "Spec" Collins urged a reorganization of the association in an attempt to make it a more effective organ for its members during the crucial years immediately ahead.

"The Concrete Products Association *can* be the most vital single factor in safeguarding the prosperity of the concrete products industry," said "Spec," *but* every member must work for his fellow members. An industry of the magnitude of ours and with its potential possibilities should engage in research, advertising, standardization, merchandising, education. All these and many other activities of a co-operative nature are essential and powerful weapons necessary to face the competition of today. The sooner our activities become integrated into the organized activity of the whole industry, the sooner the concrete products manufacturers will be ready to fight effectively in the new competition.

"It is high time that the members respond to the financial needs of the association and place it in a position to do as splendid work as its competitors in the clay and lumber industries are doing.

"The future of the Concrete Products Association lies in a working association. This calls for reorganization and a broadening of our endeavors."

New Officers

Officers elected for the coming year are Newton D. Benson, Providence, R. I., president; D. R. Collins, Milwaukee, Wis., first vice president; Austin Crabbs, Davenport, Ia., second vice-president; A. G. Swanson, Omaha, Nebr., secretary-treasurer. In addition, as previously noted, F. O. Matthiessen, Philadelphia, was appointed executive secretary.

Pacific Coast Building Code Completed

The "Uniform Building Code," 1927 edition, prepared by the Pacific Coast Building Officials Conference, came off the press late in February, after having undergone some changes from the "proof copy" that was distributed in limited quantity at the annual meeting of the Conference in Phoenix, Arizona, last October.

Among the more important changes made since October there are several that affect both reinforced concrete and concrete masonry units. In the chapter on reinforced concrete, for instance, the working stress for hard grade billet-steel bars, for rail-steel bars, and for cold-drawn steel wire, was increased from 18,000 to 20,000 lbs. per sq. in. For some reason the stress for billet-steel of the intermediate grade was left at 18,000. It is considered probable that future editions will drop the hard grade billet-steel and increase the working stress in the intermediate grade to 20,000. Except for this difference, the chapter on reinforced concrete is in close agreement with the recommendations of Committee E-1 of the American Concrete Institute.

In concrete masonry units the regulations in the code are of far-reaching importance. These units are divided into Grade A and Grade B. Grade A units must have a compressive strength over the gross area of not less than 1,000 lbs. per sq. in. and an absorption not exceeding 8 per cent. Grade B units must have a compressive strength of not less than 700 lbs. per sq. in. over the gross area and an absorption not exceeding 10 per cent, by weight. In both instances a correction factor is introduced to provide for units made of light aggregates. Furthermore, the absorption requirement is omitted in cases where the compressive strength over the gross area exceeds 1,200 lbs. per sq. in., or where the units are not exposed to dampness, or where they are coated with stucco.

There is a further provision of great importance to the concrete block industry, namely, that all concrete block and tile manufactured under the inspection service of the Underwriters' Laboratories and meeting the Underwriters' specifications shall be classified as Grade A. The wall thicknesses for Grade A units may be the same as for solid brick walls in similar locations, whereas the thicknesses for Grade B units must be greater. In a word, Grade A units are for all practical purposes put on the same basis as solid masonry.

The 1927 edition of the "Uniform Building Code" is copyrighted, in contrast to the preliminary edition of 1926, which was not copyrighted. The basis upon which cities may use the copyrighted edition will be explained upon request, by J. E. Mackie, secretary, Pacific Coast Building Officials Conference, 19 Pine Avenue, Long Beach, Calif.

Advertising and Selling Concrete Products

By NEWTON D. BENSON

LET us first consider the relation between advertising and selling. In our line of business, advertising is commonly expected to bring inquiries, rather than direct orders. It bears the same relation to sales attack, that the barrage used in the World War did to military attack—it paves the way. If we can make our advertising sufficiently forceful to present the general merits of our case, and cause the reader to become interested to the extent that he will call for more information, then we have accomplished our purpose.

To get these inquiries from prospects, we use the classified advertisements and an occasional display advertisement in the daily papers, telephone and city directories, the building laws handbooks, calendars and blotters and a few novelties. Programs and year books have generally not been considered good media.

Signs on well maintained trucks, giving the name, the nature of the business and the telephone number, form a very effective style of advertising. Paraffin-coated cardboard signs placed on all jobs are another means of keeping the name before the public.

Direct mail advertising is as effective in our business as it is in other lines. Letters may set forth the various advantages of concrete products in general or explain the special features of some particular unit like brick or tile. To obtain the best results such letters should be made up in series, and sent out at regular intervals. They can be planned in a progressive form, the sales arguments becoming more intense as the series progresses, and may even be followed up with a personal call. Such letters would be sent to a carefully prepared list of architects, contractors and prospective builders. Even if letters like these are not thoroughly read, enough of their contents will be seen to get the advertiser's name to the attention of the prospect.

In any case, put yourself on record by having your advertisement in every medium where a prospect would expect to find it and also everywhere that your competitor's advertisement appears. In short, keep your name so constantly before the public that it will become synonymous with your business. Publicity pays.

A few years ago it was a general belief that business was a process of first manufacturing an article and then finding a market for it. Now, in importance, at least, selling precedes manufacturing. This doesn't mean that we should not keep a sizeable stock on hand. Frequently a prospect for a large order wants to see all the stock required for his job—and even more—before he will buy. This is especially true with rush jobs. A large stock is one of the best talking points.

Continuous Effort Necessary

To maintain our plants at a high rate of output and avoid overproduction, continual intensive effort must be made for sales volume. This requires considerable carefully planned promotional work. One of the best fields for such work is with the architects or with builders who prepare their own plans and specifications. By properly presenting the merits of concrete products it is possible to get them specified in place of other materials or at least as an alternate. This has been done very successfully in many localities.

Then, there are often projects where substitutions are allowed and where, with proper presentation, products can be put to new uses. For example, only recently a reinforced floor was built using the standard concrete wall tile in place of the usual tile construction. We must cultivate alertness to see the sales possibilities in all new projects. Investigate every new project with the question, "How can concrete products be applied to this work?" Make this a slogan; keep it before you and see how many new outlets you will find for your product.

A frequent canvas of regular and prospective customers is sure to bring results. This canvas should, as far as practicable, be by personal visit. In this manner work in prospect can be listed and followed up. General experience indicates that the closer one keeps in touch with a prospective customer the better is the chance of getting the order. I have even seen this carried to the point where the salesman who was on the spot when the customer was ready to decide received the order.

In the newer method of selling, the salesman analyzes the customer's needs and helps him to determine how he may get the best results with the product, often showing him methods of using the product to effect real savings. This applies especially to the buyer who is new at construction. Co-operation with such a customer is much appreciated and helps toward repeat orders.

The practice of pushing a sale regardless of the buyer's interest cannot be too strongly condemned. We are hurting our best interests, as well as the customer's, when we sell him something that does not fit his needs. If tile is better adapted to his requirements and we have only block it would be much better to recommend him to the tile man, where this is possible, than to try to force him to use block, or the tile could be procured for him even though the profit to us was small. This procedure would be appreciated by the customer, would help to maintain our standing with him, and would be more profitable in the end.

And now just a word about our competitors. I think we all recognize that we seriously hurt our standing and lessen our sales effort when we say anything detrimental in regard to our competitors. It is by far the best plan not to mention them and if they are mentioned by the customer a reasonable lack of knowledge is admirable. Drawing comparisons is only courting trouble. In fact, mentioning a competitor advertises him and may indicate on our part a fear of his competition.

In quoting prices on work much pains must be taken. You must accurately know your costs, making sure that all general and overhead expense items are properly included. Having made a price based on such information, have the courage of your convictions, and stick to it.

A paper delivered before the National Concrete Products Association convention at Philadelphia.

EDITORIALS

What Is Quality Concrete?

OFFHAND it seems easy to answer this question. Quality concrete, of course, is ***strong*** concrete. True, but is that the ***only*** measurement we have for quality in concrete?

This question was repeatedly asked during the recent convention of the American Concrete Institute. Various speakers, approaching the subject from many viewpoints, came back again and again to that question.

Several times the statement was made that we, in our incomplete understanding, have made a god of compressive strength and are fanatically worshipping at its shrine. New uses of concrete, new studies of the properties of concrete, revaluations of data from old studies, all point to the belief that new standards of measuring quality are needed.

Before each job, careful short time tests on ***strength*** are made. From these, it is possible to predict with reasonable accuracy what the later strength of the concrete will be. We can even predetermine the strength of the concrete we make within certain limits. But, with all our knowledge, we cannot predict with certainty that, under given conditions, the concrete we place will have the qualities that will enable it to absolutely withstand deterioration over a given period of years. We have no definite means of measuring ***durability.***

It is known, of course, that when the fundamental requirements for making concrete are fully complied with, it is reasonable to expect durable concrete. But there may be other factors such as workability, quality of cement, admixtures, nature and proportioning of aggregates, methods of placing and surface treatment or finish that may have a very important influence on the durability of concrete. Is not durability as important a requirement for quality as strength?

Concrete must be made more uniformly durable. If there are definite relationships between density and durability, between crazing and durability, between volume changes and durability, these should be determined. Perhaps after they have been determined through research, methods of testing can be developed that will make it possible to predict durability from tests made while the concrete is being placed, as strength can now be predicted.

Save the Surface

MORE and more, as exposed monolithic concrete is being used for both the interior and exterior of buildings, the question of surface quality comes to the front. Especially for such uses, the concrete surface ***must*** be attractive and dependable.

Here, again, the question of quality of concrete and its effect on surface appearance and durability must be taken into account.

The growing use of concrete, especially on the Pacific coast, for filler and panel walls poured integrally with the structural frame, is largely dependent on securing satisfactory surface texture and resistance to weather. Such concrete fills the double purpose of providing both the structural and architectural elements in the building.

On how well we will be able to control the results needed in surface qualities will depend on the extent to which these newer uses of concrete will persist and extend.

Cast Stone Specifications

THE recent organization of the cast stone manufacturers and the appointment of a committee of the American Concrete Institute to formulate standard specifications for cast stone are steps that will mean much to this branch of the concrete products industry.

This evidence of action is the result of a growing need that has recently been so definitely realized by cast stone manufacturers that co-operative effort to remedy the lack has been possible.

Many problems confront the committee that will be appointed to work on the assignment. There are now any number of methods of specifying cast stone and little agreement exists regarding fair methods of testing to determine whether the stone embodies those qualities required by architects. Cast stone is a building material possessing a different inherent structure than other building stones because of its very nature and method of manufacture and for that reason it is possible that some of the tests now applied indiscriminately to both natural stones and cast stone are fundamentally unfair.

Cast stone manufacturers having data or opinions on these matters should get in touch with the officers of the newly formed association, the first meeting of which is reported on another page in this issue.

St. Francis Dam Failure

Preliminary Investigations Point to Foundation Failure as Cause of Collapse of St. Francis Dam Located 45 Miles North of Los Angeles

By C. W. GEIGER

INVESTIGATIONS sponsored by various governmental organizations are under way to determine the cause or causes for the failure of the St. Francis dam of the Los Angeles aqueduct, which collapsed the night of March 12th.

Without warning, the huge dam, impounding 38,000 acre feet of water, suddenly gave way, causing great loss of life and tremendous property damage as the released waters rushed furiously onward through San Francisquito canyon and the Santa Clara river valley. The dam, an arched concrete structure of the gravity type, was located approximately 45 miles north of Los Angeles in the San Francisquito canyon, which empties into the Santa Clara river valley through which the waters flowed to the Pacific ocean.

A remarkable feature of the failure was the fact that there still remains a section about 100 feet in width and 205 feet in height standing in the center of the dam. The quality of the concrete in this section was shown by the fact that the coarse aggregate had been broken cleanly in two.

In the accompanying photos, Figure 1 is taken looking up the stream and shows the center section 100 feet in width still standing. This photo shows how, according to geologists, the dam was constructed on the San Francisquito earthquake fault, the line of the fault being easy to trace in this photo. The general character of bedrock, according to the geologists, is schist, black gouge and red conglomerate. The southeast end of the dam (that end shown to the right of the center standing section) abutted against the schist wall of the canyon which was of ancient origin, and this mass had faulted against a younger conglomerate. The plane of dislocation between this ancient schist and the younger conglomerates was directly beneath the dam. The face of the schist has been washed bare by the torrent. The rock below the fault has a light color, the dark colored material above the fault line being conglomerates and sandstone of a reddish color.

There were pieces of concrete 60 feet by 60 feet by 70 feet that were washed downstream by the powerful flow of waters. On one of these blocks a geologist found schist, a part of the original bedrock. He also found black gouge from the fault as well as red conglomerate. There was evidence of sharp shattering.

Foundation Failure

Insufficiency of the foundation on which the dam rested was held responsible for the failure of the dam and consequent disaster by the chief construction engineer of a

Continued on Page 50

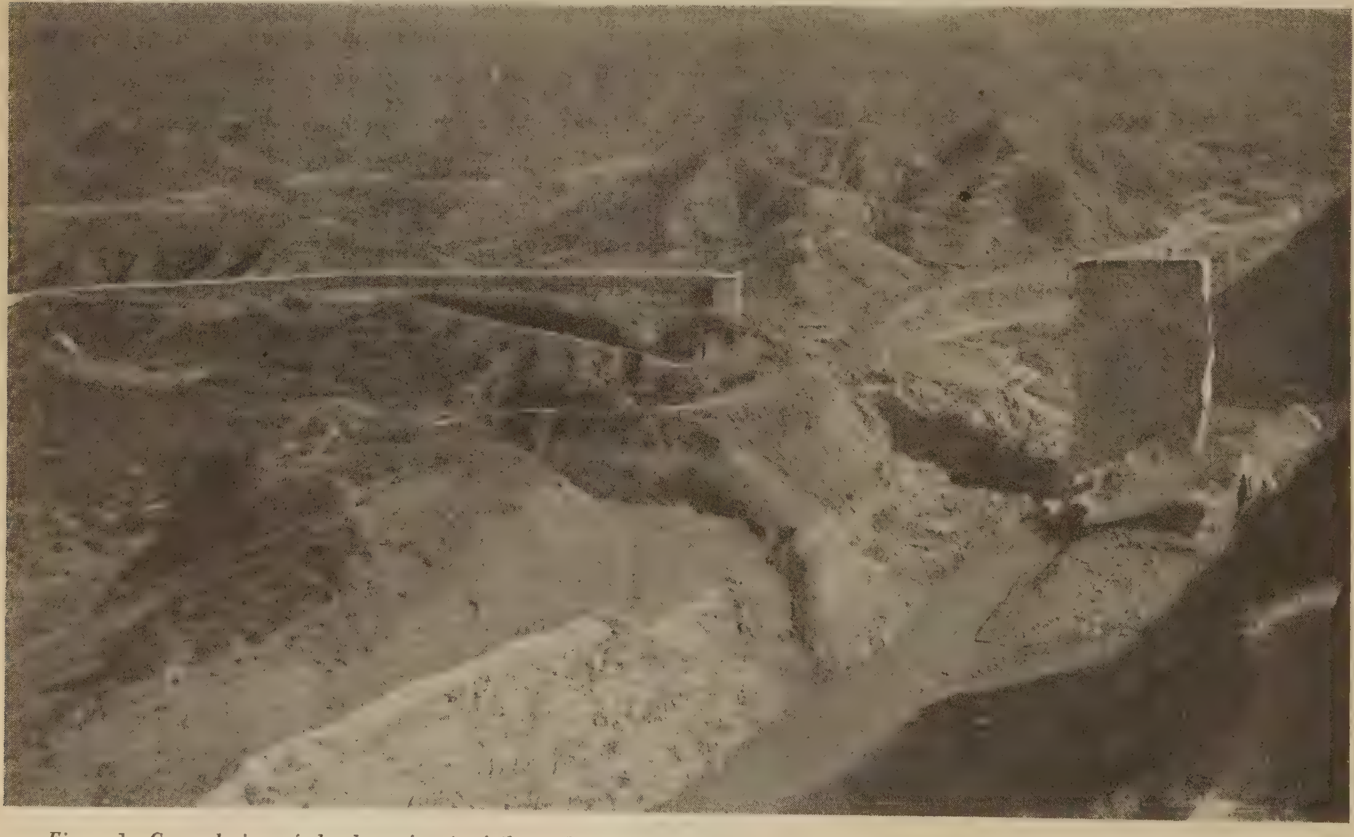


Figure 1. General view of the dam after its failure, showing the center remaining portion. The white line running from the foreground to the open section of the dam indicates the San Francisquito earthquake fault

What Workability Means to the Contractor

How Workability Can Be Secured by the Contractor—What It Means to Him—Influence of Aggregates — Admixtures — Effect on Labor Costs—Transporting Concrete

By N. L. DOE*

DURING the past five years, remarkable progress in the making and placing of concrete has been made. The contractor of today realizes that a properly designed mix which will produce workable concrete is necessary. Furthermore, the up-to-date contractor is well aware that workable concrete is much more economical, as to cost of materials and expense of handling, than the average concrete made without a calculated mix.

Variations in theories of design, the range of aggregates, the different requirements of structures in which concrete is used, the extensive array of modern field equipment available, and the difference in labor markets, introduce so many variables that the production of a workable concrete with a maximum economy becomes a study worthy of considerable attention.

To produce a concrete of given strength, having maximum workability at minimum expense, the cost of materials and labor must be properly proportioned.

Workability as Affected by Materials

Considering first the cost of increasing workability by altering the material content of the concrete, we find that the following possibilities are usually present:

1. The addition of more cement, at the same time adding sufficient water to keep the water-cement ratio a constant.
2. A variation in the amount and grading of the aggregate.
3. The use of an admixture.

Workability of concrete for complicated portions of structure is commonly increased by the addition of more cement than the specifications require. This practice is probably true economy. There is no question as to the effect of extra cement. The workability increases as the amount of cement is increased and the quality of the concrete is improved.

Whenever additional cement and water are added for the purpose of increasing workability, due care must be used to see that the water-cement ratio is not increased, otherwise a decreased final strength will result. By mixing a few trial batches containing various amounts of additional cement, each batch being made with the correct water-cement ratio, the effect of extra cement on the quality of the concrete can be observed, and the increased cost of obtaining better workability by this method can be determined.

In cases where it is impossible to alter the grading of the aggregates, additional cement and water will give increased workability without excessively increasing the cost of the concrete. In the average situation, however, sufficient workability can be secured in more economical ways.

The second possibility for increasing the workability of concrete by variations in the aggregates used is probably the most attractive and interesting study from an economic standpoint. The fact that all aggregates having the same fineness modulus produce concrete of the same strength, other conditions being identical, has been quite generally established and accepted. Perhaps it has not been as fully emphasized that different aggregates having the same fineness modulus do not produce concrete of the same workability, or yield the same volume. These features are important from the contractor's point of view, and present opportunities for increasing workability and yield with no sacrifice in final strength, by a regrading or reselection of aggregate. It is not unusual to find different aggregates in the same market sold for approximately the same prices that produce concretes in which the cement factors vary from 10 to 25 per cent with a corresponding range in workability. This variation of yield and workability due to the grading of aggregates applies to both large and small materials. Poorly graded crushed stone will always give less workability and a smaller yield than a well graded gravel of the same fineness modulus. Likewise, bank sand running heavy in fine materials will show better results than a sand taken from water, which is apt to be lacking in fines. In studying the effect of sands upon workability, the percentage of material passing the No. 28 and 48 sieves is very important. Sands to give workable mixes should have a sufficient percentage of suitable materials passing these sieves. Sands that do not contain sufficient fine materials give harsh mixtures and show excessive cement factors.

Illustration of Economy

To illustrate this point, it is interesting to compare two sands sold in the New York market for the same price: Sand No. 1 has a fineness modulus of 2.46, with 59 per cent passing the No. 28 sieve, and 19 per cent passing the No. 48 sieve. Sand No. 2 has a fineness modulus of 2.80 with 44 per cent passing the No. 28 sieve, and but 6 per cent passing the No. 48 sieve, according to the grading tabulated below:

	—Per cent coarser than sieve—	
Sieve No.	Sand No. 1	Sand No. 2
4	0.6	0.6
8	5.6	6.8
14	17.4	22.4
28	41.2	56.2
48	81.2	93.8
100	100.0	100.0
	246.0	279.8
Fineness modulus—	2.46	2.80

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The final records of one New York contractor, covering two similar building operations, involving 57,000 yds. of 2,000 lb. concrete, placed by the same field force, under similar conditions and with the same coarse aggregate, but with Sand No. 1 used on one project, and Sand No. 2 on the other, showed a cement factor of 1.24 for the finer sand compared with a factor of 1.48 for the coarser sand. In other words, one more bag of cement per yard of concrete was used with the No. 2 sand. These records seem to bear out experiments on yield values and show to the contractor the importance of obtaining properly graded materials.

In any locality, then, the first effort toward securing workability in an economical manner, should be to intelligently select the aggregates. A careful sieve analysis of those available should be made, and actual test yields compared. Unless a proper combination of aggregates is selected, maximum economy and workability cannot be expected.

Admixtures

The third way in which workability can be altered by changing the material content is by the use of an admixture, such as lime or Celite.

Neither of these admixtures as commonly used seems to affect the final strength of the concrete to any extent. Both materials increase the workability, apparently in the same manner that the addition of very fine aggregates or extra portland cement increases workability. Both cost considerably more than portland cement, and the handling of the admixture involves another operation at the mixer. For ordinary concrete work, it will usually prove cheaper to increase the workability by a change in the aggregates or by the use of additional cement or both, than it will to use an admixture. Under conditions where exceptional workability is necessary; in isolated locations where transportation of cement is costly; or where properly graded aggregates cannot be obtained, Celite or lime may work out as a distinct advantage. When considering the cost of admixtures, the bulking effect of Celite on certain concretes should not be neglected.

Workability as Affected by Labor

The quality of workability bears a very close relation to the handling and placing operations wherever concrete is used. The most important features in the field which affect workability are as follows:

1. The plant layout for handling and measuring materials before they enter the mixer.
2. Transportation methods and means.
3. Care and system used in placing concrete in the forms.
4. General control and regulation of field operations.

The type of equipment used for mixing concrete has changed very little since the first Ransome mixer was built. It can be safely said that the majority of mixers as designed today are satisfactory and will produce a thoroughly mixed concrete if properly handled. The principal changes that have been made in equipment tending toward more uniform workability are in the devices for measuring or weighing either the cement, aggregates, or the water. On many modern plants, sand inundators, automatic water tanks, and hoppers for accurately measuring or weighing aggregates have been installed and successfully operated. Aggregates must be measured accurately and each batch must contain the correct amount of water, if uniform workability is to be secured. There are, however, economic limits to this accuracy of measurement which must be considered when measuring or weighing equipment is selected.

The cost of installation per yard of concrete is normally higher for smaller operations, than where large volumes of concrete are handled. The cost of operating elaborate plant installations also runs heavy per yard of concrete unless handled very efficiently.

Frequently also conditions at the site prevent the installation of plants requiring considerable head room. For such reasons, it is often sound economy to knowingly sacrifice sufficient additional cement to allow for reasonable variations in measurements, and install a simple plant, without precise measuring devices. For instance, a labor and material charge for special plant items, installation and increased operating expenses amounting to 50 cents per yard, would cost the contractor about the same as though an extra bag of cement had been added to each yard of concrete. The additional bag of cement, however, would certainly produce the more workable and stronger concrete. Possibly the increased interest in quality concrete has served to over-emphasize the importance of elaborate measuring equipment. Simple devices, well supervised, will produce accurate results at a very considerable saving in concrete costs.

Transportation of Concrete

In the transportation of concrete from the mixer to the forms, workability is a feature of prime importance. Workable concrete can be transported long distances by various means without appreciable segregation. For short hauls, such as found on building work, the two wheeled buggy still ranks as the most efficient carrier. Concrete moved in buggies if very wet, tends to segregate somewhat, all the fine materials rising, while the heavy aggregates settle into a solid mass at the bottom. A direct saving in labor in discharging from the buggy results if the concrete is mixed workable enough so that this condition does not exist, for workable concrete when deposited from the buggy leaves the bottom of it clean, and does not require reworking when it is placed in the form.

For longer hauls, where considerable quantities of concrete are to be carried, belt conveyors or chutes are economical means of transportation for workable mixes. In the future, probably more belt conveyor systems will be used than have been seen in the past, owing to their economy of operation, and great capacity. It must be kept in mind that neither of these systems will transport a non-workable concrete with any degree of satisfaction. Workable concrete is easily handled—non-workable mixes clog chutes, segregate on belts, and cannot be recombined at the delivery end into a satisfactory concrete. Conveying concrete by means of chutes has been unjustly criticized in the past, and equipment blamed in many cases where the real trouble was improperly mixed concrete.

Concrete containing an excess of water segregates to such an extent when conveyed by chutes that the heavy aggregate becomes lodged at some point and blocks the chute. Likewise concrete mixed too stiff is carried very slowly, and is apt to form blockades. The delays resulting, while chutes are being cleared are expensive, and point convincingly to the fact that workable and uniform concrete is a necessity for labor efficiency if chutes are used.

In connection with all methods of transportation, the advantage of bottom dumping equipment and its effect on workability, should be mentioned. Hoisting buckets, truck bodies, hoppers, derrick skips, and similar equipment tend to remix the concrete, and increase workability if the discharge is from the bottom rather than over the side.

Cost of Placing Concrete

The labor cost of placing concrete in the forms is always increased if the mix is not workable. On many classes of work, various consistencies must be used for different portions of the structure. These different parts of the structure may be included in the same day's work, and require an intelligent change in the mix if efficient labor costs are to result. An illustration of this is the case of an inclined concrete slab for a sawtooth roof, which might be concreted monolithic with several bays of flat roof. The concrete for the inclined roof must be placed much stiffer, and be made more workable than the concrete ordinarily required in the flat roof, if the work is to be handled at a minimum cost. In some cases to insure proper placing at low labor cost, it may be desirable to use specially graded aggregates for part of the work, as in the case of fireproofing around the bottom flanges of heavy beams, or in locations where reinforcing is extremely complicated. This means that a knowledge of the workability required for different work must be exercised by those in charge and advantages taken where opportunity permits if concrete is to be placed economically and well. On all structures, the surfaces of the freshly placed concrete should be kept as level as possible. Concrete arriving at the forms segregated should be remixed, with shovels. The forms should be filled in an orderly manner, with few fresh edges left exposed.

Concrete for ordinary structures should be so designed that practically no free water will accumulate on its surface. If pools of water do form as the concrete is placed, they should be removed by shovels and pails. Excess water should not flow over the edge of forms, or the face of the concrete, as segregation will result, and the quality of the concrete will be impaired.

On structures which require finished surfaces, workability shows a real saving in labor when the finishing operations are considered. Labor costs for pointing up and repairing honeycombed areas are high and soon over-balance the extra expense that would change a non-workable mix to one of proper workability.

Determining Economical Mix

To protect his own interests in the field of concrete today, it is necessary for the contractor to establish some definite method of control and check on the performance of his organization. This may be made quite elaborate, and extensive, or it may be comparatively simple as the case seems to require. For ordinary operations, the following system is recommended as a help in obtaining economical workability:

1. Before work is started, a careful study of the available aggregates should be made and those producing the most workable concrete and giving the highest yield values should be selected.
2. Proper mix designs should be made and tested for concrete of the strengths and workabilities required by the structure to be built.
3. Proper facilities for insuring the correct quantities of cement, water, and aggregates should be provided at the mixer. Daily checks on batches of materials entering the mixer and an inspection of the volume of concrete discharged from the mixer are a necessity. At regular intervals, not over two weeks apart, cement and aggregate factors should be computed and recorded, based on total quantities used and concrete yardage placed.
4. Test cylinders made from different sections of the work as it goes forward should be broken when one week old and the concrete strength noted in permanent records. A set of these cylinders should be cast at least every other day that concrete is placed. Twenty-eight day strengths should be computed from actual 7-day tests, and at intervals extra cylinders should be made so that actual 28-day tests can be checked.

By a study of the results obtained in the above manner, the contractor is not only able to assure himself that concrete of the required strength is being placed, but the cost of workability obtained from different aggregates soon becomes apparent. Without some such record of past performance to serve as a basis of comparison in the selection of materials and field methods, true economy in securing workability cannot be realized.

Enclosed Concrete Stairways

Enclosed concrete stairways, of the type seen in the center of the accompanying photograph, have been built by numerous owners of summer cottages on high bluffs just over the edge of the ocean at Laguna Beach, California.

Important Scottish Bridge

The new King George V bridge at Glasgow, Scotland, opened to traffic recently, is claimed to be technically the most important structure built in Great Britain in reinforced concrete. The bridge is intended to relieve the abnormal traffic congestion in the center of the city. In July, 1927, King George laid the memorial stone of the bridge, which is in three spans. The center arch is 146 feet in length, while the two other spans are each 110 feet in length, the width of the bridge being 80 feet. The bridge is 423 feet long from center to center of abutments. It is built of concrete embellished with Dalbeattie granite.

Powers for the construction of the bridge were obtained from Parliament in 1914, but owing to the war it was not until 1921 that the Glasgow Corporation was able to proceed with the project. In 1924, a beginning was made in sinking the foundations. The total cost will be from £250.000 to £300,000 ($1,250,000 to $1,500,000). Part will be paid by the Ministry of Transport and the remainder will be borne equally by the Statute Labor and the Glasgow Tramways Department.

Instrument Developed for Measuring Cracks in Concrete*

Bureau of Public Roads Secured Accuracy of 0.25 Per Cent—Details of Operation

By H. L. BOSLEY
Assistant Materials Engineer, United States Bureau of Public Roads

AN instrument for use in measuring the length of cracks in concrete pavements and with which measurements can be made rapidly and with a satisfactory degree of accuracy has recently been designed by the Division of Tests of the Bureau of Public Roads. The instrument was made for use on concrete surfaces in making condition surveys in connection with subgrade studies and to determine the effect of various features of design.

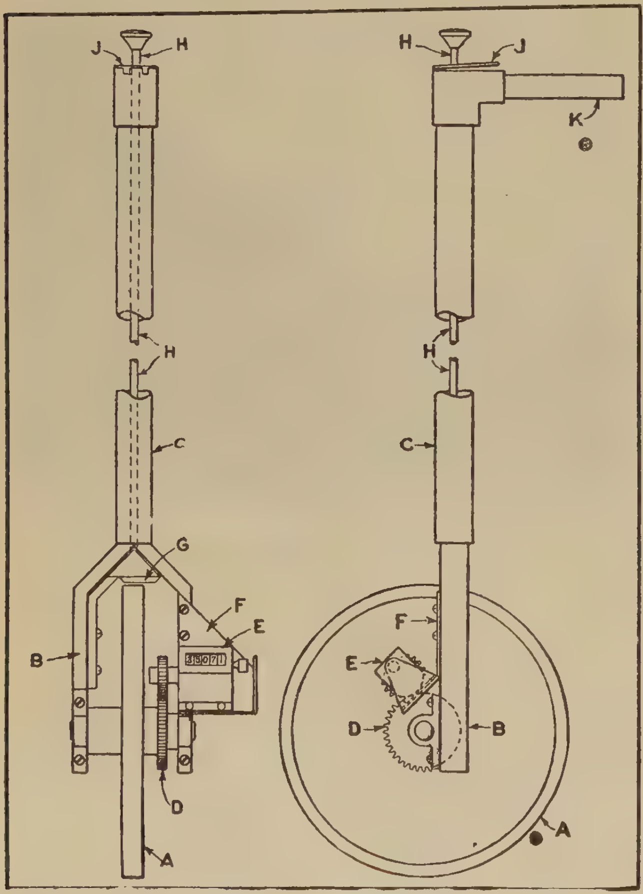

Figure 1. Details of device. Wheel, A, rolls in bearings supported by the forked frame B, attached to the handle, C. A pair of spur gears, D, rotate the spindle of the revolution counter, E, twice for each revolution of the measuring wheel, A

The apparatus, which embodies the same principle as the chartometer used for measuring distances on maps, consists of a wheel which is rolled along the surface to be measured by means of an operating handle. The circumference of the wheel being known, it is so geared to a revolution counter that for each linear foot of travel one unit is recorded on the counter. Thus, the reading on the counter at any time shows the total distance over which the wheel has been rolled.

One man with the instrument can replace two men with a tape and obtain the same data more easily and it is believed more accurately. A second advantage is that the actual length of meandering cracks can be accurately measured, something which cannot readily be done with a tape. Calibration tests with one of these devices indicated that lengths measured at the speed of a man walking were accurate to within 0.25 per cent or 1 foot in 400. A check on the individual measurements is available at all times in the total on the counter which will record nearly 20 miles before clearing.

How It Is Made

The details of construction are shown in Figure 1. A steel wheel, A, whose circumference is exactly 2 feet, rolls freely in bearings supported by the forked frame, B, attached to the tubular handle, C. A pair of spur gears, D, rotate the spindle of the revolution counter, E, twice for each revolution of the measuring wheel, A. Thus for each distance of 1 foot traversed one unit is registered on the counter. The counter, E, is supported and protected by a guard bracket, F. In transporting the apparatus from one place to another it is desirable to prevent rotation of the counter spindle. For this purpose a rubber brake shoe, G, is provided and this is pressed against the measuring wheel, A, by the rod, H, which terminates in a knob at the end of the operating handle. The operator simply presses down on this knob and locks the wheel, the brake being held in contact by the latch, J. To release the brake a slight pressure on the end of the latch, J, frees the rod, H, and permits the wheel, A, to again roll freely.

Reinforced Concrete Towers Ordered for Transmission Use

Among the important contracts recently placed for work required in connection with the plans of the British Central Electricity Board's project for co-ordinating the electrical undertakings of Scotland is one for 1,530 large reinforced concrete towers which are to be erected for carrying the high voltage transmission lines.

A beginning is being made in the work of preparing the foundations of the towers, and the process of erection will be started about a month later. The foundations will consist of masses of concrete containing steel anchors, to which the structure above will be fixed. They will be about 30 feet in diameter, and the tower will be square in formation, and painted so as to harmonize as far as possible with its surroundings.

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*Abstracted from *Public Roads.*

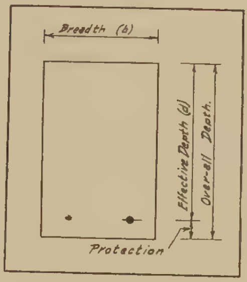
Reinforced Concrete Design Simplified

Chart A—Beams Reinforced for Tension

By PROF. JAMES R. GRIFFITH
Armour Institute of Technology; Assoc. M., A. S. C. E.

Joint Committee Specifications

$f'_c =$ 2,000 lbs. per sq. in. $M = Kbd^2$
$f_c =$ 800 lbs. per sq. in. $A_s = pbd$
$f_s =$ 18,000 lbs. per sq. in. $K = 138.7$
$n =$ 15 lbs. per sq. in. $p = 0.0089$



THE ideal and economical beam reinforced for tension only would, when the full load was applied, have both the concrete and steel stressed to their allowable limit at the section of maximum moment. This condition is commonly termed "Balanced Reinforcing." On account of the commercial sizes of reinforcing steel in use and practical considerations for the saving of form lumber, this ideal condition is seldom attained. It is used, however, as a basis for determining the necessary sizes and later, if necessary, is investigated for actual stresses.

Chart A Application

Chart A has been prepared on the basis of balanced reinforcing with the limiting values as shown above. Any straight line across all scales will intercept values, on each scale, which will satisfy the conditions for balanced reinforcing. If any two values are known, or assumed, the remaining variables are quickly obtained.

Example

Required: To design a beam, reinforced for only tension, for a simple span of 18 feet with a live-load of 375 pounds per linear foot. Limiting values being $f_c = 800$ pounds per square foot, $f_s = 18{,}000$ pounds per square foot, and $n = 15$.

The Joint Committee specifies a bending moment for a beam of one span, carrying a uniform load of

Maximum positive moment near center,

$$M = \frac{w\,l^2}{8}$$

Then, L.L. Bending Moment $= \dfrac{375 \times 18^2 \times 12}{8} =$ 182,000 in. lbs.

While this live-load bending moment does not include any of the dead-load weight of the beam itself, it will be used in order to get some approximation of the dead-load.

The breadth (b) of a beam, for economical design, should be from ½ to ¾ of the effective depth (d). The beam bottom is usually formed first and should be of such dimension as to conform to standard lumber sizes in order to save costly ripping. Referring now to Chart A, a pencil is held on the live-load bending moment of 182,000 in. lbs., and a straight edge laid on the chart against the pencil point. The straight edge should preferably be of some transparent material such as a drafting triangle. The straight edge will now intersect the two outside scales at values of (b) and (d) which will satisfy the conditions of balanced reinforcing. As we desire to have (b) satisfy the two conditions of being about ½ to ¾ of the depth (d) and also an even inch, the straight edge can be rotated about the pencil point till such conditions are obtained. When the straight edge passes through a breadth of 8 inches and a moment of 182,000 in. lbs., it will be seen, by the dotted line on Chart A, that the other scales are intercepted at values of:

Effective Depth = 13 in.
Approx. Dead-load = 125 lbs. per ft.

When the bending moment is increased so as to include the effect of the dead-load of the beam, the beam section must also be increased, which will increase the approximate dead-load value. This increase in dead-load is usually about 20 per cent, although several trials can be quickly made if necessary.

Correction

In the introductory article of this series, published in the March issue, an error was made in presenting Equation 7 on page 16.

Equation 7 should be as follows:

$$\text{Long Co-ord. } C = L^{mn/r}\, R^{m(1-n)}$$

instead of

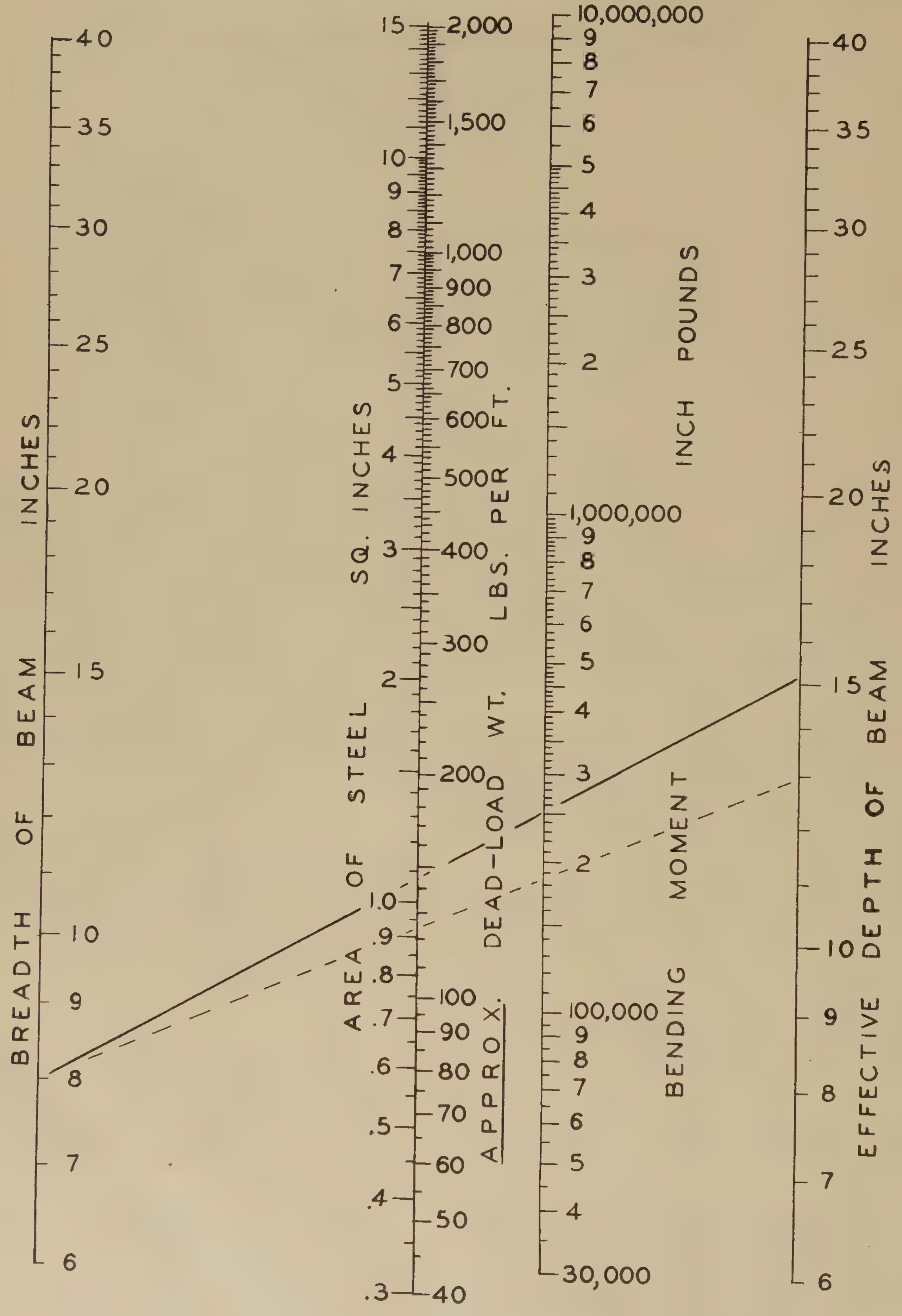
$$C = L\frac{mn}{r}\,Rm(1-n)$$

as printed.

CHART A

Balanced Tensile Reinforcing for Concrete Beams

$f_c = 800$ $f_s = 18{,}000$ $n = 15$



D.L. of beam for L.L. Moment = 125 lbs. per ft.
Estimate of 20 per cent increase = 25 lbs. per ft.

Probable Total Dead-Load = 150 lbs. per ft.

Increased Moment

Since the bending moment varies directly with the unit load, the increased moment will be figured by direct proportion:

$$\text{Total Mom.} = \frac{\text{L.L. Mom.}}{\text{L.L.}}(\text{L.L.} + \text{D.L.}) =$$

$$\frac{182{,}000}{375}(375 + 150) = 256{,}000 \text{ in. lbs.}$$

Shifting the pencil to the new bending moment of 256,000 in. lbs., the straight edge is again laid against it and rotated to a desirable combination of breadth and depth. A desirable combination is obtained, as shown by the solid line on Chart A, when the breadth is again 8 in. All scale intercepts will then be:

Moment (M) = 256,000 in. lbs.
Breadth (b) = 8 in.
Depth (d) = 15.2 in.
Area of Steel = 1.07 sq. in.
Approx. D.L. = 145 lbs. per ft.

Dead-Load Weight Checked

A dead-load weight of 150 lbs. per ft. was assumed and checked by an approximate dead-load of 145 lbs. per ft. The effective depth would probably be decreased to 15 inches, figuring that any combination of commercial bars will probably be in excess of the necessary area of steel, thereby justifying some decrease in depth. If 2 inches of protection is used below the steel, the actual dead-load of the beam would be:

$$\text{Dead-load} = \frac{8(15 + 2)}{144}150 = 142 \text{ lbs. per ft.}$$

which is figured on the basis of concrete weighing 150 lbs. per cu. ft. This actual weight would then check the assumed by 8 pounds, which would be considered close enough for practical purposes.

Steel Reinforcement

While 1.07 sq. in. of steel area is required, the nearest to this in commercial bars would be

3—¾-inch round bars = 1.3254 sq. in.
2—⅞-inch round bars = 1.2026 sq. in.

The 2—⅞-inch bars give an area a little closer to that required, but the 3—¾-inch bars give a better distribution and still meet the requirements as to spacing.

Joint Committee Specifications

The Joint Committee Specifications state: "The minimum clear distance between parallel bars shall be 1½ times the diameter of round bars or 1½ times the diagonal of square bars. . . . Bars parallel to the face of any member shall be embedded a clear distance of not less than one diameter from the face. . . . Metal reinforcement in fire-resistive construction shall be protected by not less than 1 inch of concrete in slabs and walls, and not less than 2 inches in beams, girders and columns . . ."

In choosing combinations of steel, the requirements of spacing and protection must always be considered. The minimum spacing is to assure adequate bond between the steel and concrete, and should be sufficient to permit the aggregate to pass between bars.

The finished section is shown in Figure 1-A.

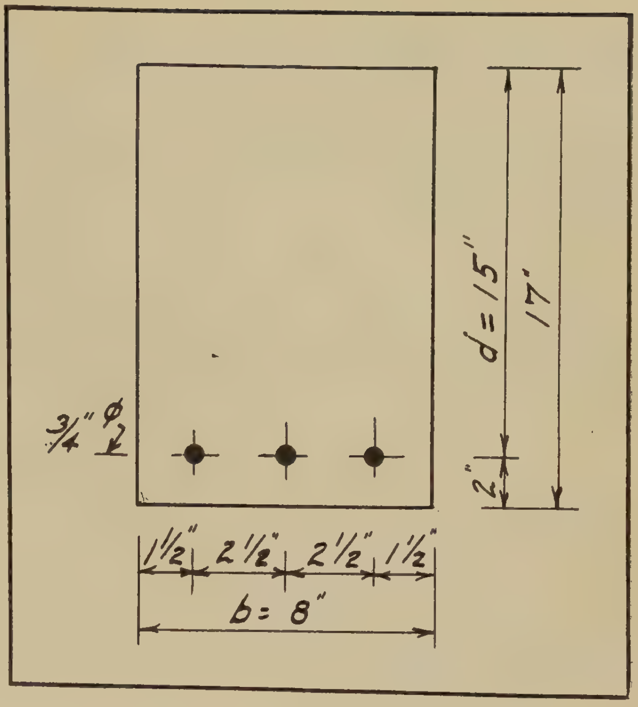


Figure 1A

Analytical Solution

The Joint Committee Specifications make the following general assumptions:

(a) Calculations are made with reference to working stresses and safe loads rather than with reference to ultimate strength and ultimate loads.

(b) A plane section before bending remains plane after bending, shear distortions being neglected.

(c) The modulus of elasticity of concrete in compression is constant within the limits of working stresses and the distribution of stress in beams is rectilinear.

(d) The moduli of elasticity of concrete in computations for the position of the neutral axis, for the resisting moments of beams, and for compression of concrete in columns, are as follows:

(1) 1/15 that of steel, when the compressive strength of the concrete at 28 days exceeds 1500 and does not exceed 2200 lbs. per sq. in.
(2) 1/12 that of steel, when the compressive strength of the concrete at 28 days exceeds 2200 and does not exceed 2900 lbs. per sq. in.
(3) 1/10 that of steel when the compressive strength of the concrete at 28 days is greater than 2900 lbs. per sq. in.

(e) In calculating the moment of resistance of reinforced concrete beams and slabs the tensile resistance of the concrete is neglected.

(f) The bond between the concrete and metal reinforcement remains unbroken throughout the range of working stresses. Under compression the two materials are therefore stressed in proportion to their moduli of elasticity.

(g) Initial stress in the reinforcement due to contraction and expansion of the concrete is neglected except in the case of concrete columns.

As we have decided to use a concrete with an ultimate strength of $f'_c = 2000$ lbs. per sq. in., it will be seen from paragraph (d-1) that the modulus of elasticity of the concrete will be 1/15 that of the steel. The modulus of elasticity of any material is defined as the ratio of unit stress to unit deformation or

$$E = \frac{\text{Unit stress}}{\text{Unit deformation}}$$

The ratio of the modulus of elasticity of the steel (E_s) to that of the concrete (E_c) is represented as (n), which in this case becomes

$$n = \frac{E_s}{E_c} = 15$$

On the assumption in paragraph (f), when the two materials are deformed the same amount the ratio of the steel stress (f_s) to that of the concrete (f_c) is also equal to (n), or

$$\text{Unit deformation} = \frac{\text{Unit stress}}{E}$$

which, when the expressions for concrete and steel are equated become

$$\frac{n\,f_c}{E_c} = \frac{f_s}{E_s}$$

On this basis, the Joint Committee Specifications give the following formulas for the computation of concrete beams reinforced for tension only:

Position of neutral axis

$$k = \sqrt{2pn + (pn)^2} - pn \qquad \text{Eq. 1-A}$$

Arm of resisting couple

$$j = 1 - \frac{k}{3} \qquad \text{Eq. 2-A}$$

Compressive unit stress in extreme fiber of concrete

$$f_c = \frac{2M}{jkbd^2} = \frac{2pf_s}{k} \qquad \text{Eq. 3-A}$$

Tensile unit stress in longitudinal reinforcement

$$f_s = \frac{M}{A_s jd} = \frac{M}{pjbd^2} \qquad \text{Eq. 4-A}$$

Steel ratio for balanced reinforcement

$$p = \frac{1}{2}\left[\frac{1}{\dfrac{f_s}{f_c}\left[\dfrac{f_s}{nf_c} + 1\right]}\right] = \frac{A_c}{A_s} \qquad \text{Eq. 5-A}$$

The various nomenclature in the above formulas are shown in Figure 2-A.

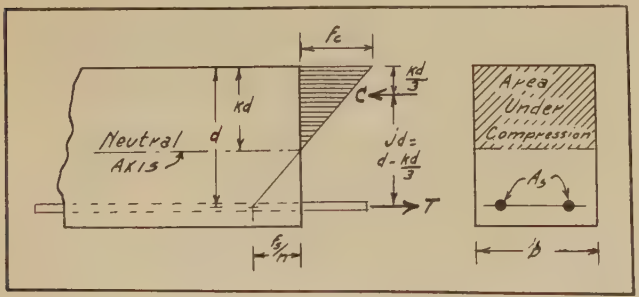


Figure 2A

In the summary of working stresses, March issue, the allowable working stress in the extreme fiber of the concrete was taken as

$$f_c = 0.40\,f'_c$$

Since we are going to take the conditions of the ultimate strength of concrete (f'_c) as 2000 lbs. per sq. in., the allowable working stress will become

$$f_c = 0.40 \times 2000 = 800 \text{ lbs. per sq. in.}$$

The area of concrete (A_c) given in Eq. 5-A, is the so-called "effective area."

$$A_c = bd$$

So Eq. 5-A can be transposed and written

$$A_s = pA_c = pbd$$

The ratio (p), called "the percentage of steel," then becomes a constant value for any combination of steel and concrete stress for balanced reinforcing. In our case the percentage becomes

$$p = 0.0089.$$

The resisting moment of the beam at any section is produced by a force-couple, Fig. 2-A, in which the total compression (C) is equal and opposite to the total tension (T) with an arm equal to (jd). The total compression (C) is considered as applied at the center of gravity of the compression triangle which comes at a point 1/3 the altitude of the triangle from the top of the beam and is equal to $\frac{k}{3}$.

The resisting moment can be written

$$M = Cjd = Tjd$$

The total compression is equal to the area of the compression triangle multiplied by the breadth (b) of the beam, or

$$C = \frac{f_c kd}{2}\,b$$

The resisting moment of the concrete (M_c) can then be written

$$M_c = Cjd = \left(\frac{1}{2}f_c kbd\right)jd$$

which is nothing more than another form of Eq. 3-A.

The total tension (T) is taken as the product of the average steel stress (f_s) and the area of the steel (A_s), and is considered as being applied at the center of the steel area.

$$T = A_s f_s$$

The resisting moment of the steel (M_s) can then be written

$$M_s = Tjd = A_s f_s jd = pbdf_s jd = f_s pjbd^2$$

which is another form of Eq. 4-A.

Since the total compression (C) is equal to the total tension (T), they can be equated. Thus

$$M_c = M_s$$

$$\frac{1}{2}f_c kjbd^2 = pf_s jbd^2$$

The variable on either side of the equality sign is (bd^2), all other values being constant for balanced reinforcing for any combination of stresses. If the product of all of the constants on either side be taken as (K), the expression can be written

$$M = Kbd^2$$

Wherein

$$K = \frac{1}{2}f_c kj = pf_s j$$

Substituting the values of $(n = 15)$ and $(p = 0.0089)$ in Eq. 1-A, a value is obtained of

$$k = 0.4000$$

which, when substituted in Eq. 2-A, gives a value of

$$j = 0.8667$$

The value of (j) is frequently taken as $(\frac{7}{8})$ for all combination of stresses where a slight variation makes little difference. The value of the constant (K) then becomes

$$K = 138.7$$

The two expressions

$$M = 138.7\,bd^2$$

$$A_s = 0.0089\,bd$$

now give a very simple method of solving for the desired quantities for balanced reinforcing. When the bending moment is given for the live load, some assumption for a dead-load value must be made, and also either (b) or (d) must be assumed. This is very troublesome for the inexperienced designer as he has no initial conception as to the probable sizes necessary. A number of trials and assumptions must usually be made, and for this reason alone, the chart gives not only a very quick solution but also a conception as to the effect of the several variables.

If the dead-load weight as found from Chart A is used, D.L. = 145 lbs. per lin. ft., a check on the chart solution may readily be obtained.

Total load = (L.L. + D.L.) = 375 + 145 = 520 lbs. per ft.

$$M = \frac{wl^2}{8} = \frac{520 \times 18^2 \times 12}{8} = 252{,}000 \text{ in. lbs.}$$

$$M = Kbd^2 = 138.7\,bd^2$$

Assuming a breadth of ($b = 8$ in.), and solving for (d)

$$d = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{252{,}000}{138.7 \times 8}} = \sqrt{227} = 15.1 \text{ in.}$$

The area of steel then becomes

$$A_s = pbd = 0.0089 \times 8 \times 15.1 = 1.075 \text{ sq. in.}$$

It will be seen that these values check very well with those obtained from the chart.

As changes were made in both beam size as well as the area of steel in the final solution, Figure 1-A, balanced reinforcing no longer exists and the stresses should, in case of doubt, be investigated.

Using the actual values, we have

D.L. weight = 142 lbs. per ft.
$A_s = 1.3254$ sq. in.
$b = 8$ in.
$d = 15$ in.

From Eq. 5-A we then have

$$p = \frac{A_s}{A_c} = \frac{1.3254}{8 \times 15} = 0.01105$$

Substituting this value of (p) and the value of ($n = 15$) in Eq. 1-A, we get

$$k = 0.399$$

and from Eq. 2-A

$$j = 1 - \frac{0.399}{3} = .867$$

The actual bending moment is

$$M = \frac{wl^2}{8} = \frac{(375 + 142) \times 18^2 \times 12}{8} =$$

248,00 in. lbs.

Substituting in Eq. 3-A

$$f_c = \frac{2M}{jkbd^2} = \frac{2 \times 248{,}000}{.867 \times .399 \times 8 \times 15^2} =$$

800 lbs. per sq. in.

Substituting in Eq. 4-A

$$f_s = \frac{M}{A_s jd} = \frac{248{,}000}{1.3254 \times .867 \times 15} =$$

14,450 lbs. per sq. in.

Thus it will be seen that the concrete stress is up to the allowable limit, while the steel stress is quite low. We were then justified in decreasing the value of (d) to even inches as originally stated. An experienced designer might check the concrete stress in such a case, but would know that due to the increase in steel area the unit steel stress would be low. If a group of steel bars could be found to give a total area just a little below that required, an increase in the beam section would probably be justified. In such a case, the steel stress should be investigated.

Contruction of Chart A

Many readers will be interested in knowing how such charts are constructed. Some may be skeptical and want a proof that it is all right. Others may want to construct a similar chart for other combinations of stress. Still others may wish to become familiar with general nomograph construction. So a detailed description of the construction will be given.

The area of steel for balanced reinforcing is obtained from the expression

$$A_s = pbd = 0.0089\,bd$$

Referring to Eq. 7 ($C = L^{mn/r} . R^{m(1-n)}$) for the construction of nomographs, March issue, it will be seen that it corresponds to the equation in question, requiring the use of logarithmic co-ordinates.

If the left scale (L) be taken for values of (b), and the right scale (R) for values of (d), the central scale (C), will contain values of (A_s). Since the range of values for (b) and (d) are about the same, they can be laid out with the same sized co-ordinates. Thus the ratio (r) becomes unity. The exponents of both variables in the equation in question, it will be noted, are unity. In order to determine the unknowns (m) and (n), giving the relative scale spacing and co-ordinates, it is necessary to equate the general to the actual exponents. We then have:

$$\left.\begin{aligned} \frac{mn}{r} = \frac{mn}{1} &= 1 \\ m(1-n) &= 1 \end{aligned}\right\}$$

When solved simultaneously, these equations give the values:

$$\left.\begin{aligned} n &= \frac{1}{2} \\ m &= 2 \end{aligned}\right\}$$

The central scale must then be located midway between the (b) and (d) scales, and the co-ordinates for the central (A_s) scale must be one-half the size of those used on the right (d) scale. At the start, it was decided to have the co-ordinates on the left (b) scale the same as those on the right (d) scale.

The only effect of the co-efficient ($p = 0.0089$) is to shift one of the scales up or down. A construction isopleth through the values ($b = 6$) and ($d = 6$) will cross the (A_s) scale at a value of

$$A_s = \text{pbd} = 0.0089 \times 6 \times 6 = .32 \text{ sq. in.}$$

With this information, all three scales can be quickly laid out. In constructing the original of Chart A, the graduations on the (D) scale of a 10-inch slide rule were used for the (b) and (d) scales, while the (A) scale of a 10-inch slide rule was used for the (A_s) scale. The choice of scales is largely arbitrary, so long as the relative size is maintained, depending upon the limits desired.

Bending Moment

The resisting moment for any section with balanced reinforcing is found, for the stresses herein considered, by the expression

$$M = Kbd^2 = 138.7\,bd^2$$

This also resembles the general Eq. 7 ($C = L^{mn/r}.R^{m(1-n)}$) for nomographs with logarithmic co-ordinates in which the outside scales will still be values of (b) and (d). If the same (b) and (d) scales were used as for finding A_s, the ratio of (r) would again be unity. Equating the general to the actual exponents, we would have:

$$\left.\begin{aligned} \frac{mn}{r} = \frac{mn}{1} &= 1 \\ m(1-n) &= 2 \end{aligned}\right\}$$

When solved simultaneously, these equations give the values:

$$\left.\begin{array}{l} n = \dfrac{1}{3} \\ m = 3 \end{array}\right\}$$

Thus the (M) scale will be located one-third from the (d) to the (b) scale, and its co-ordinates will be one-third the size of those used for the (d) scale. The original construction isopleth through values of $(b = 6)$ and $(d = 6)$ crosses the (M) scale at a value of

$$M = 138.7\, bd^2 = 138.7 \times 6 \times 6^2 = 29{,}960 \text{ in. lbs.}$$

Using the (K) scale of a 10-inch slide rule, the (M) scale can now be laid out.

Dead-Load Weight

The actual dead-load weight of a beam depends upon the overall dimensions of that beam. The writer has, however, found that the addition of a scale giving *approximate* dead-load values adds to the convenience of Chart A for preliminary estimates. In order that a solution isopleth, or straight line, from scales (b) and (d) will also give dead-load information, the dead-load equation must be written as a function of these same values. As (d) is the effective depth of the beam, instead of the overall depth, therein lies the approximation.

The minimum protection below the steel is specified "not less than one diameter" except in fire-resistive construction when it shall be "not less than 2 inches in beams, girders and columns." Actually, the protection varies with the size of the beam due to the fact that in the larger beams heavier steel is used and many times several rows are necessary. In most cases this protective covering varies from $d/6$ to $d/8$, so the average value of $d/7$ was taken for the approximation. The dead-load weight of the beam in pounds per linear foot, for the beam dimensions in inches, would be expressed by the equation

$$\text{D.L.} = \frac{150\,(8d/7)\,b}{144} = 1.19bd$$

As this equation is similar in every respect to the equation for the area of steel $(A_s = pbd)$, wherein the exponents of both variables are unity, the values of (m) and (n) would also be the same. The dead-load scale will then be on the same line as the (A_s) scale and have the same size logarithmic co-ordinates. The same construction isopleth through $(b = 6)$ and $(d = 6)$ will cross the D.L. scale at a value of

$$\text{D.L.} = 1.19\, bd = 1.19 \times 6 \times 6 = 42.8 \text{ lbs. per ft.}$$

The dead-load scale can then be laid out from this point, completing Chart A.

A key to the size and spacing of all scales as used for the original of Chart A is given in Figure 3-A. Scale sizes are by letter and number as described in detail in the March issue.

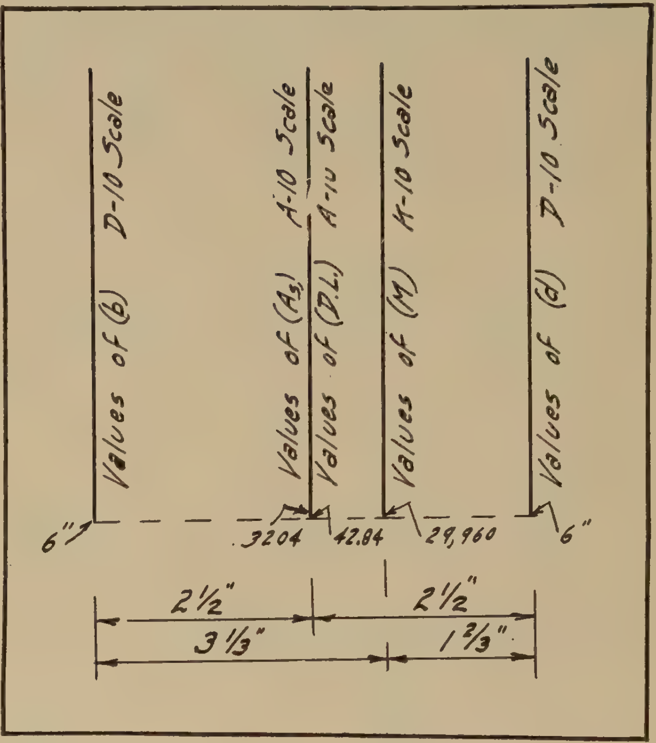


Figure 3A

Any other combination of stresses will affect only the values of (p) and (K). Changing these constants will have the effect of shifting the scales up or down, but will not change either the relative size of the co-ordinates or the spacing of the scales. In substituting for the intersection of the construction isopleth through $(b = 6)$ and $(d = 6)$, or any other combination of values desired, new values at the intersection of each scale will be obtained. The scales can then be rapidly laid out.

Building Operations Take Healthy Climb

Building operations, showing a remarkable seasonal vigor, are abreast of the volume of activities reported for the early weeks of the record-breaking year of 1927, according to statistics just compiled by the Associated General Contractors of America.

Building and engineering contracts awarded during February in the 37 states east of the Rocky Mountains amounted to $465,331,300, the F. W. Dodge Corporation reports. The figure establishes the highest February contract total ever recorded for the 37 states, exceeding by 9 per cent that of the month previous and by 18 per cent the record made a year earlier.

The A. G. C. report further states that the volume of all types of construction work performed during January and February of 1928 is equal to the corresponding total recorded for last year. The Dodge corporation allots construction according to type east of the Rockies as follows: 51 per cent for residential buildings, 13 per cent for public works and utilities, 12 per cent for commercial buildings, 8 per cent for social and recreational projects, and 7 per cent for industrial buildings.

Indication that construction operations will have a running start in entering the mid-summer season is found in the large volume of contracts recently awarded. This volume in January was the second greatest ever registered for that month of any year on record, being ten per cent greater than the corresponding total for January, 1927, though slightly below the peak figure established during the first month of 1926.

The February contract total brought the amount of work started since the first of this year up to $892,500,000, this being a gain of 15 per cent over the amount started in the first two months of last year.

New work contemplated during the past month in eastern states amounted to $947,003,400. This figure shows an increase of 5 per cent over the amounted reported in the preceding month and was 50 per cent ahead of the amount reported in February, 1927.

Bookkeeping— The Key to Profit *in Products Plant*

The Third Article in This Series Showing How Accurate Bookkeeping Increases Profits—This Chapter Continues the Discussion of Manufacturing Costs Begun in the February Issue—Distribution of Manufacturing Overhead Expense—Allocation of Operating Costs to Specific Units—Overhead Per Unit—Actual Cost vs. Normal Cost—Total Manufacturing Cost

By **WILLARD R. GINDER, C. P. A.**
Formerly Assistant Treasurer, National Building Units Corporation
Consulting Accountant, National Concrete Products Association

Part III

Overhead Expense

SOUND accounting practice requires that overhead expense be divided, so that only a certain portion of it shall be applied to manufacturing cost. Certain items, such as selling expenses, must not be included in costs at which inventories are priced, and custom has therefore established the differentiation between manufacturing cost and total cost.

Before discussing the general accounting of overhead expense, however, we think it advisable to continue the discussion of manufacturing cost, and will therefore defer descriptions of overhead expense accounts, distributions, etc.

Manufacturing Overhead Expense

Having decided which items of expense are to be classed as manufacturing expense, our next problem is to determine how this expense affects manufacturing cost per unit of each style and size.

It will be noted that we have previously divided the manufacturing process into four parts, i. e., Preparation of Aggregate, Mixing, Molding and Curing (including Storing). This division will be continued throughout our discussion of manufacturing cost, so that full cost data relative to each part of the process will be obtained.

Distribution of Overhead Expense to Departments or Parts of the Process, i. e., Operations

All manufacturing expenses do not affect each part of the process in the same proportions. Some affect operations in proportion to the ground area occupied, some according to value of equipment used, some according to supervision required, and some items are directly chargeable to specific operations.

In very large manufacturing plants where the manufacturing process is complex, it is necessary to distribute overhead upon a much more elaborate plan than that indicated above. We believe, however, that very few block plants will find it of practical value to attempt much finer classification.

Expenses usually found in a block plant are and may be generally classified as follows:

Ground Area Occupied

Rental of Ground
Real Estate Taxes on Ground
Maintenance of Driveways, Fences, etc.
Watchmen
Sundry Labor, Cleaning, etc.

Volume of Building Space Occupied

Depreciation of Buildings
Maintenance of Buildings
Insurance on Buildings
Rental of Buildings
Real Estate Taxes on Buildings
Watchmen
Heat and Light
Cleaning and Sundry Labor

Value of Equipment

Depreciation of Equipment
Insurance on Equipment

Supervision

Superintendent's Salary
Foremen's Salaries or Wages
Portion of Office Expense
Supplies
Testing
Damaged and Broken Blocks

Direct Charges

Water
Power
Maintenance of Equipment
Pallet Cleaning and Oiling
Heat for Kilns

After classifying the expenses as above, it is necessary to determine in what proportions ground area, volume of building space, value of equipment and supervision affect each part of the process. This is the most difficult part of the problem, but fortunately it is only necessary to work it out once, unless extensive alterations to the plant are made subsequently.

Average cost per month of the ground area group may easily be divided into three parts, in proportion to area occupied by plant buildings, aggregate storage, and area not so occupied. The portion applicable to buildings now

Figure 8

STANDARD CONCRETE PRODUCTS CO.

MANUFACTURING OVERHEAD EXPENSE DISTRIBUTION

Month of ____________, 192__.

ACCOUNTS	Amounts for Month	DISTRIBUTION BASES				Operation A	Operation B	Operation C	Operation D	Aggregate	Cement	Hauling Blocks	Hauling Mat. Sold
		Grd. Area	Bldg. Space	Val. of Eq.	Supervision								
Power, Heat & Light	xx		xx			xx	xx	xx					
General Plant Expense	xx		xx										
General Yard Expense	xx	xx											
Repairs—Buildings	xx		xx										
Repairs—Mach. & Eq. Oper. A	xx					xx							
Repairs—Mach. & Eq. Oper. B	xx						xx						
Repairs—Mach. & Eq. Oper. C	xx							xx					
Repairs—Mach. & Eq. Oper. D	xx								xx				
Repairs—Yard	xx	xx											
Rent	xx	xx	xx										
Water	xx						xx						
Taxes—Real Estate	xx	xx	xx										
Insurance	xx		xx	xx									
Small Tools	xx				xx								
Pallet Cleaning & Oiling	xx							xx					
Supplies	xx				xx								
Telephone	xx				xx								
Testing	xx				xx								
Salary—Management	xx				xx								
Supervision	xx				xx								
Watchmen	xx	xx	xx										
Sundry Indirect Labor	xx				xx								
Depreciation—Buildings	xx		xx										
Depreciation—Mach. & Equipt.	xx			xx									
Depreciation—R. R. Siding	xx									s xx			
Depreciation—Yard Equipment	xx								xx				
Depreciation—Motor Trucks	xx									c xx	c xx	xx	xx
Motor Truck Maintenance	xx									c xx	c xx	xx	xx
Motor Truck Insurance	xx									c xx	c xx	xx	xx
Proportion of Office Expense	xx				xx								
Sub-totals	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx
Ground Area Basis		*xx*	xx						xx	s xx			
Building Space Basis			*xx*			xx	xx	xx	xx		s xx		
Value of Equipment Basis				*xx*		xx	xx	xx	xx				
Supervision Basis					*xx*	xx	xx	xx	xx				
To Aggregate Cartage*	*xx*									c *xx*			
To Aggregate Storage*	*xx*									s *xx*			
To Cement Cartage*	*xx*										c *xx*		
To Cement Storage*	*xx*										s *xx*		
To Hauling Blocks*	*xx*											*xx*	
To Hauling Material Sold*	*xx*												*xx*
Credit Manufacturing Expense	*xx*												
Net Manufacturing Expense	xx					xx	xx	xx	xx				

*Debit these accounts by Journal Entry, crediting Manufacturing Expense Relief Account.

becomes a charge to the volume of building space group, that applicable to aggregate storage becomes a direct charge to that account, and the balance may be used as a direct charge to block curing and storing. The inaccuracy introduced by failure to allow for area occupied for driveways, office building, etc., may be safely ignored.

Volume of building space cost may be reduced to an amount per cubic foot, and charged to portions of the process on the basis of cubic feet of space occupied. This is not burdensome, as it is only necessary to apportion the cubical content of buildings among the operations once, unless extensive changes in layout are made.

Value of equipment cost becomes more or less a direct charge, and is easily distributed. Some difficulty may be experienced in apportioning value of equipment in use among parts of the process, but after it has once been done, it will not be difficult to revise it from time to time.

Supervision cost is probably most easily distributed to parts of the process, on the basis of direct labor. If greater accuracy is desired, supervision cost may be charged so as to follow all labor, and so that direct charges for maintenance and repairs, for instance, will carry with them their proportion of supervision expense.

Direct charges may be made to parts of the process somewhat as follows:

Water to B.

Power to A, B, C and D in proportion to horse power of motors and average number of hours each motor is operated.

Pallet cleaning and oiling to C.

Heat for kilns to D.

Maintenance of equipment to A, B, C and D, on basis of actual cost of such work.

It will probably be necessary to further analyze items chargeable to operation C, so that the proper overhead applicable to each molding machine may be determined.

All of the above distribution may be accomplished without great consumption of time and effort, and without introducing an elaborate outline of accounts in the ledger.

Manufacturing Expense Accounting and Distribution

At the end of each month, the portion of office expense which is to be charged to manufacturing expense, usually about one-third, is so charged by journal entry. Proportion of office expense account in the manufacturing expense group is debited, and office expense relief account in the office expense group is credited.

All manufacturing expenses for the month are now entered on the manufacturing overhead expense distribution, a suggested form for which is presented in Figure 8. Each amount is then carried out into the column indicating the basis upon which it is to be spread over the various activities. Some accounts may contain items which are directly applicable to certain activities, in addition to general items which are to be spread upon one of the four standard bases, and some entire accounts are directly applicable to certain activities. All such amounts are carried directly to the column representing the activity affected, and become direct charges.

After all accounts have been distributed among the basis and activity columns, all columns are totaled and the sheet is proved for mathematical accuracy to this point.

The total of each basis column is then divided among the activity columns, in accordance with the methods previously discussed. This results in closing the basis columns.

Totals of the non-manufacturing activity columns then form the basis of a journal entry, whereby aggregate and cement storage and cartage accounts, and hauling accounts are debited, and manufacturing expense relief account is credited. Giving effect to this entry on the sheet results in closing the non-manufacturing activity columns, and in reducing the total column proportionately; so that totals of the remaining open columns reflect the amounts applicable to each manufacturing operation and net total expense applicable to manufacturing, for the month.

Allocation of Operation Costs to Specific Units

After classifying the overhead expense in accordance with the method by which it is distributed over operations, and determining the amount applicable to each operation, we are ready to consider methods of allocating overhead to units manufactured.

Some favor allocating all overhead on the basis of direct labor cost, but careful consideration shows this to be unsound. If 8-inch block were made on a multiplex machine on one hand, and on an automatic on the other, the overhead rate per dollar of direct labor would be the same on both machines by this method, and the machine having the highest direct labor cost per unit would have the most overhead charged to its product. This would result in the multiplex product being overburdened with overhead, and the automatic product not receiving its proper share.

This method disregards the facts that charges for power, maintenance and space occupied, cost of operation per hour, attendant labor required and rate of production are different for each type of machine.

Others favor allocating all overhead in proportion to the sum of direct labor and material cost. This method merely reduces the error of the first method to a slight extent.

Overhead Per Unit—Operations A and B

It will be readily admitted by all, no doubt, that overhead applicable to material preparation will affect cost per unit in proportion to the amount of material contained therein. We may therefore allocate overhead of operations A and B, to types and sizes manufactured, in the same way that material cost and direct labor cost of those operations were allocated.

Overhead Per Unit—Operation C

If average total molding overhead per month is distributed over the machines on the floor, by some logical method, average overhead per month applicable to each machine will be obtained. These amounts may then be reduced to machine hour rates, and allocation to specific units then becomes quite simple.

The question then arises: How many hours per month should be used in determining the hour-rate? This is not so easily answered.

For computing actual cost, we suggest that the hour-rate of each machine be based upon the average number of hours per month during which that machine is actually operated.

Actual Cost vs. Normal Cost

It is at this point that the difference between actual cost and normal cost is well illustrated.

In computing normal cost, the number of hours upon which hour-rates are based is the number of hours per month during which any machine should normally be operated. If mixer capacity were great enough to operate all molding machines at the same time, all hour-rates would be based upon the same number of hours, i. e., the number of hours per month during which the mixer should normally be operated. If mixer capacity were not great enough to operate all molding machines at the same time, the hour-rate basis for all machines would be reduced proportionately, or some normal basis would be fixed for each machine, so that the sum of all would equal normal mixer output.

However, we are discussing computation of actual cost, and cannot therefore digress further.

Actual Cost Machine Hour Rates

Having determined the average actual number of hours each machine is operated per month, and the average overhead per month applicable to each machine, overhead divided by hours will give machine hour-rate. Machine hour-rate divided by number of any type or size unit produced per hour on that machine will give operation C overhead per unit.

H equals average number of hours operated by machine per month.

O equals average monthly overhead applicable to machine.

R equals overhead of machine per hour—i. e., hour-rate.

O divided by H equals R.

N equals average number of units of given style and size produced by machine per hour.

R divided by N equals overhead per unit for operation C.

Overhead Per Unit—Operation D

The overhead on operation D is largely in direct proportion to direct labor involved in that operation, with the exception of charges for space and equipment used. The latter charges vary in proportion to the gross volume of individual types and sizes, or the spaces occupied in the racks, kilns and yard.

Charges for space and equipment will probably be relatively small, however, and as direct labor cost will be influenced by sizes and weights, we may safely assume that all of operation D overhead varies in proportion to direct labor.

Overhead is easily allocated to individual types and sizes on the direct labor basis, by determining the overhead per dollar of direct labor, and applying this to the direct labor cost per unit.

L equals average total operation D direct labor per month.

O equals average operation D overhead per month.

R equals overhead per cent of direct labor.

O divided by L equals R.

Lu equals operation D direct labor per given style and size unit.

R multiplied by Lu equals operation D overhead per unit.

The entire manufacturing overhead expense has now been allocated to each style and size unit manufactured, as follows:

Operations A and B—In proportion to material used or dry-weight produced.

Operation C—In proportion to cost of operating machines used.

Operation D—In proportion to direct labor used.

Total Manufacturing Cost

Total manufacturing cost consists of the sum of material cost, direct labor cost and overhead expense, each of which has been considered, and methods have been discussed whereby each item of cost per unit of any type and size may be ascertained.

It will be noted that the methods suggested largely consist of breaking down the total cost and expenses shown by the books, to obtain the proportion applicable to each unit manufactured. This results in assurance that all applicable items of cost and expense have been included.

(To Be Continued)

Shreveport Adopts Modified Draft of Pacific Coast Building Code

Final action on the new building code for Shreveport, La., was taken by the city council of that city on February 28. The code has been given legal publication in a local newspaper, and will soon be printed in book form by the Building Code Publishers of that city.

The Shreveport building code represents many months of work by a committee of five, of which the chairman was K. C. Wilson, of the Glassell-Wilson Co., general contractors. The committee used the preliminary draft of the proposed uniform building code for Pacific coast cities, published in September, 1926. Every section was given careful study with the view of adapting the requirements of that code to the specific needs of the geographical location of the Louisiana city. Changes were made also in the first three chapters, pertaining to administration, in order to conform to local requirements.

With specific reference to the major building materials, the chapter on masonry construction was left as printed in the preliminary draft of the Pacific coast code, which, in turn, was taken from the recommendations of the Department of Commerce Building Code Committee.

The chapter on reinforced concrete, taken from the proposed "Standard Building Regulations for Reinforced Concrete," first issued by the American Concrete Institute in 1925 and incorporated in the Pacific coast code, was left as printed, with one exception. This included incorporation of the higher working stresses for reinforcing steel as recommended in the 1928 issue of the American Concrete Institute report.

The chapter on structural steel was modified so as to be in conformity with the recommendations of the American Institute of Steel Construction, whereas the Pacific coast code is in several respects more liberal than the recommendations of the organization representing the steel industry.

The chapter on timber construction was modified to include the recommendations of the Southern Pine Association.

Interest in the Shreveport code developed in other cities as its preparation progressed. Between the time of adoption on second reading on February 14 and final reading on February 28 the city councils of Meridian, Miss., and Beaumont, Tex., adopted the Shreveport draft without change.

Printing was started promptly at Meridian, and it is probable that the Mississippi city will be the first of the three to have its code in book form. Six or eight other cities have the Shreveport code under consideration, and it is not improbable that its adoption will spread to many others. Because of the thorough study given to the Shreveport code by men who are well representative of the building industry of the South, building code committees and building officials in other cities are inclined to consider it favorably.

Construction Details on Ohio Super-Highway

Mayfield Road Near Cleveland Was Interesting Job—Two Mixers Placed Parallel Strips of Concrete Pavement—Blast Furnace Slag Used as Aggregate—Construction and Finishing Details — Test Cylinders Showed High Quality of Concrete Secured

THE Mayfield road in Cuyahoga County, Ohio, extending from the east line of Cleveland Heights to Gates Mills, was completed during the past season, utilizing the old pavement on hills and curves as a base for the new concrete slab. The new pavement was built to replace an old narrow pavement and for a distance of 5.9 miles consists of two strips of concrete, each 18 feet wide, separated by an unimproved strip 22 feet wide. For a distance of 1.8 miles from the Berkshire road on through the village of Gates Mills the new pavement consists of a single strip of concrete, part being 24 feet wide and the remainder 32 feet wide. The total length of the project is 7.7 miles.

Bids were taken on three types of construction. Four-inch brick on concrete base—three-inch asphalt on concrete base—and ten-inch reinforced concrete slab with the edges thickened to 13 inches on the inside. The award was made on the concrete type of pavement at a unit price of $3.40 per square yard. As the double strip pavement is 3 inches thicker than the ordinary pavement construction in the state and the depth of concrete varied on the single strip section, these factors were taken into consideration in making comparison with other projects.

Subgrade Preparation

The rough grading for the double strip section was done with three power shovels and the subgrade shaped with a grader pulled by a five-ton tractor and rolled by a ten-ton roller. After this rolling a form subgrader was used followed by a five-ton roller. Just before the concrete was placed a scratch template of standard design was used to insure a uniform subgrade.

The double strip pavement section has a raised sandstone curb on the outer edge of each strip, and on the hills or all grades of from 8 to 10 per cent, raised granite curb was installed on the edges of the single strip pavement.

Placing the Concrete

In mixing and placing the concrete on the two parallel strips of pavement two Foote mixers were used, one a 27-E and the other a 21-E paver operated from the unpaved strip in the middle of the road. They were equipped with specially designed long booms for placing the concrete. This arrangement proved to be an excellent one as it permitted both the pavers and the trucks hauling materials to be kept off the subgrade. Two Lakewood finishers of the screed type were used on this section.

The method adopted for constructing the pavement was adapted to the design of the slab. As previously stated, the thickness of the double strip pavement is 10 inches with

The single strip section of the Mayfield road, showing the raised granite curb installed on the edges of such sections thickened edges, increasing the thickness of the slab to 13 inches in the outer two feet of the inner edge where there is no curbing. The thickness and depth of the concrete on the single strip section was variable, as it was placed over the old pavement. Except on the hill section the road was kept open to traffic during construction operations.

The concrete slabs were reinforced with mesh fabric having an effective weight of 56 lbs. to 100 sq. ft., the reinforcing being placed two inches from the top surface of the slab. Spanning all water and sewer trenches, most of which had been recently excavated, an extra thickness of 3 inches of concrete was placed together with additional reinforcing consisting of ½-inch round bars spaced 12 inches on centers. A ¾-inch round shear bar was placed along each edge of the slabs. Cross-overs were placed at every important road intersection.

Proportions

The coarse aggregate used was blast furnace slag, and lake sand was supplied for the fine aggregate. The proportions were approximately 1:2:3.

Frequent tests were made for the bulking of the sand and for the concrete yield with the result that the contractor used cement in excess of the 6.76 sacks to one cubic yard which is the minimum requirement for concrete under the Ohio specifications.

Test cylinders were made early in the work and showed especially good strengths, all above the average of those for pavements laid in the state that year

In constructing the slab the 27-E paver placed the concrete to within about 2 inches of the top where it was struck off by one of the finishing machines. This was followed by the placing of the mesh fabric and then the additional concrete was deposited by the second mixer operating a few yards behind the first. The usual time intervening between the placing of the bulk of the concrete and the top 2 inches was approximately ten minutes. The second finishing machine followed immediately after the second paver.

Single Strip Section

For mixing and placing concrete on the 24 ft. single section another 21-E mixer was used, together with a specially-built 24 ft. Lakewood finishing machine. A very dry mix was used on account of the specially steep grades to prevent the newly placed concrete from flowing. Slump tests showed the average slump to be ¾ of an inch. This resulted in a remarkably smooth surface. The finishing machine was run on the top of the granite curb with the strike-off 6 inches below the top of the curb. This machine was arranged to tamp and screed the concrete below the top of the curb. To provide a smooth track to run on, specially designed steel angle guides were fitted to the curb.

A smooth finish on this section was secured by the aid of a roller consisting of a 3-inch iron pipe 14 feet long. Ropes were attached at either end of the pipe to eye-bolts which were arranged so that the pipe would run when the ropes were pulled back and forth. This roller required four men to operate, two on each side of the pavement, and its weight was sufficient to force ahead of it the excess water and laitance, and at the same time fill in the voids in any dry concrete. The use of the roller also disclosed any rough places in the surface of the concrete which were corrected by repeated rolling. Steel brooms were used on the green concrete to produce a rough, non-skid surface.

The cement used throughout the project was delivered to the site by trucks and trailers and stacked along the side of the road off the subgrade, so as to be available for direct use in the mixer. This was the first major operation in Cuyahoga county on which trailers were used for hauling cement. The aggregates were also trucked to the mixer from a central batching plant in batch trucks, and dumped with the cement into the mixer skip at the point of concreting operations.

Water was supplied from hydrants along the right-of-way. In addition to the normal amount used in mixing concrete, considerable water was required to keep the covering in a moist condition in accordance with the Ohio specifications for curing the concrete with wet earth or straw. The contractor experienced low water pressure at times, which resulted in his securing a 10,000 gallon tank which was carried on a trailer behind the mixer as a reserve water supply.

Test Results

The tests results obtained on this job are of particular interest, and these results were the basis of the opinion of the State Highway Department that the Mayfield road pavement is one of the best in the state. From the beginning of the job 6- by 12-inch test cylinders were molded of concrete that was being laid in the pavement. These cylinders were sent to the State Highway Department at the Ohio State University where they were aged and tested for compressive strength.

The concrete specimens consistently showed especially good strengths. The average for the Mayfield road job for concrete cylinders showed 10 per cent above the average of concrete pavements laid by the state for the year 1926. The following averages were obtained for compressive strength cylinders tested:

At seven days	2,420 lbs. per sq. in.
At fourteen days	3,827 lbs. per sq. in.
At twenty-eight days	4,582 lbs. per sq. in.

Frequent transverse tests were also made of beams made from concrete going into the work. These tests showed an average modulus of rupture of approximately 715 lbs. per sq. inch for concrete at the age of 14 days. Further tests were conducted beyond the laboratory tests for cylinders and beams molded as the job progressed. By careful drilling at intervals of not to exceed 500 feet, cores were cut from the pavement and tested. These cores gave an average compressive strength of 5,030 lbs. per sq. inch for concrete averaging 90 days old, thus exceeding the specified requirements. These core specimens also revealed that the concrete was of uniform quality and of uniform thickness slightly in excess of specifications.

Job Finished Ahead of Schedule

Contract for the Mayfield road project was awarded on August 13, 1926 by the state of Ohio to the W. A. Dorsey

Construction Company of Findlay, Ohio. The first concrete was placed April 25, 1927, and the placing of the pavement which totaled approximately 150,000 square yards, averaging over 10 inches in thickness, was completed October 5, 1927. Progress on the job was fairly uniform and resulted in its completion before the expiration of the time limit set. The largest day's run was 915 feet of finished roadway. As the old pavement which was allowed to remain for a foundation of the new slab in certain sections had not been banked on curves the proper grade of the finished concrete pavement surface was maintained by increasing the depth of concrete placed at these points. This resulted in concrete being nearly 3 feet thick at the outer edge of super elevated curves. Such factors as this made impossible any fair comparison between the speed of construction on the various sections of the Mayfield job and on other paving jobs in the state.

No expansion joints were installed in the pavement, it being the policy and design of the Ohio State Highway Department to omit the use of transverse joints. Due to this feature of the design the pavements are expected to have transverse cracks at irregular intervals due to contraction and expansion of the continuous slab. These cracks are not considered serious by the department, and are believed to require less maintenance than improperly constructed expansion joints.

Ray Anspaugh was general superintendent for the Dorsey Construction Company, the general contractors on the Mayfield job. Harry J. Kirk is state highway engineer of Ohio and Daniel Davis was engineer and inspector for the state, on the work described. R. S. Brindell was division engineer for the state and James McLeary chief road engineer for Cuyahoga County. All materials used including cement, sand and slag were supplied by the Cleveland Builders Supply and Brick Company, Cleveland, Ohio.

Cement Requirements for Some Concrete Mixes

A Discussion of an Article by Harold Allen Published Under This Title in the November, 1927, Issue, and Presenting Another Method of Determining the Amount of Cement Required for Different Mixes in Which the Quantity of Mixing Water Used Is Taken into Account —Close Agreement with Mr. Allen's Results Is Shown

By STANTON WALKER
Director, Engineering and Research Division, National Sand and Gravel Association

IN the November issue of CONCRETE there appeared an article entitled "Cement Requirements for Some Concrete Mixes," by Harold Allen, which reports the results of determinations of the quantities of material for concrete of different mixtures. These experimental values are compared with estimated quantities, computed from a formula proposed by Taylor and Thompson and a good agreement is shown. That paper furnishes information which should be of interest and of value to all engineers interested in concrete.

In his discussion of Taylor and Thompson's formula, Mr. Allen points out that no factor is included in it which takes into account variations in the quantity of mixing water. Since the quantity of mixing water plays an important part in determining the volume of the concrete it seems that it would be of interest to compare the experimental values with ones estimated by a method which takes full account of the water.

Such a method was described in detail in Bulletin 1 of the Engineering and Research Division of the National Sand and Gravel Association, "Estimating Quantities of Materials for Concrete," by this writer. It is based on the obvious fact that the volume of the concrete is equal to the volume of the solids in the aggregate plus the volume of cement paste, so long as there is a negligible quantity of unfilled voids or entrained air. Properly proportioned concrete of a workable plasticity is practically free from unfilled voids and entrained air is negligible. Computed quantities based on this method have been found to agree extremely well with experimental values.

The following simple formula has been derived from which the barrels of cement per cubic yard of concrete may be calculated if the concrete is plastic and workable and the approximate water-ratio, the weights of aggregates used with each 94 lb. cu. ft. of cement, and the approximate specific gravities of the aggregate are known:

$$\left.\begin{array}{l}\text{Bbls. of cement}\\ \text{per cu. yd. of}\\ \text{concrete}\end{array}\right\} = \frac{6.75}{0.5 + x + \dfrac{W_f}{62.5\,S_f} + \dfrac{W_c}{62.5\,S_c}}. \quad (1)$$

Where:

x = water-ratio; ratio of volume of mixing water to volume of cement.

W_f = weight of fine aggregate in pounds used with one 94 lb. cu. ft. of cement.

W_c = weight of coarse aggregate in pounds used with one 94 lb. cu. ft. of cement.

S_f and S_c = apparent specific gravities of fine and coarse aggregate, respectively.

For aggregates of average specific gravity this equation can be reduced to the following simple form:

$$\left.\begin{array}{l}\text{Bbls. of cement}\\ \text{per cu. yd. of}\\ \text{concrete}\end{array}\right\} = \frac{6.75}{0.5 + x + \dfrac{W_f + W_c}{166.6}} \quad \ldots\ldots (2)$$

The following Table I gives quantities of cement per cubic yard of concrete determined as follows:

(1) Experimental values from Allen.

TABLE I. COMPARISON OF ESTIMATED QUANTITIES WITH MEASURED QUANTITIES

Computed from data in Harold Allen's article, "Cement Requirements for Some Concrete Mixes," published in the November, 1927, issue of CONCRETE

			Coarse Aggregate			Barrels of Cement per cu. yd. of concrete			Per Cent Variation from Measured Quantity	
Batch No.	Water-Cement Ratio	Slump, inches	Size	Fineness Modulus	Unit Weight, lb. per cu. ft.	Allen	Eq. 1	Taylor & Thompson	Eq. 1	Taylor & Thompson
					1:3:5 MIX					
1	0.95	2	3¾	8.75	81.0	1.11	1.11	1.10	0	0.9
2	0.95	4	3⅜	8.56	85.0	1.08	1.09	1.08	0.9	0
3	1.10	2½	3⅜	8.36	86.5	1.08	1.06—	1.07	1.9	0.9
4	1.19	3¼	3¼	8.10	88.5	1.03	1.03	1.05	0	1.9
5	1.19	3	2¼	7.84	88.5	1.04	1.03	1.05	1.0	1.0
6	1.26	3	2¼	7.61	90.5	1.02	1.01	1.04	1.0	2.0
7	1.27	5	2	7.26	91.0	1.03	1.01—	1.04	1.9	1.0
					1:2:4 MIX					
1	0.70	2½	3¾	8.75	82.0	1.44	1.45	1.43	0.7	0.7
7	0.75	3	1½-¼	7,30	81.5	1.43	1.44	1.44	0.7	0.7
4	0.78	2½	2⅜	8.20	85.0	1.41	1.41—	1.41	0	0
8	0.78	3	1½-¼	7.34	84.0	1.41	1.41	1.40	0	0.7
3	0.75	5	3¼	8.37	87.5	1.40	1.39+	1.39	0.7	0.7
2	0.74	2½	3¼	8.25	89.5	1.37	1.38	1.37	0.7	0
6	0.89	2¾	2¼	7.03	89.5	1.35	1.34	1.37	0.7	1.5
5	0.82	5	2¼	7.55	90.5	1.34	1.35+	1.36	0.7	1.5
					1:2:3½ MIX					
1	0.650	4	3¾	8.70	82.2	1.56	1.56—	1.52	0	2.6
2	0.675	3	2⅜	8.47	86.6	1.49	1.51	1.49	1.3	0
3	0.695	3	2¼	8.23	87.5	1.49	1.50	1.48	0.7	0.7
5	0.795	2½	2¼	6.64	88.4	1.45	1.46	1.47	0.7	1.4
4	0.780	4½	2¼	7.40	93.3	1.43	1.43	1.43	0	0
6	0.840	2½	1½-¼	6.38	84.7	1.41	1.47	1.50	4.3	6.4
					1:1¾:3½ MIX					
1	0.65	2½	3⅜	8.39	86.1	1.58	1.59—	1.57	0.6	0.6
2	0.67	3	2⅜	7.97	85.9	1.58	1.58	1.57	0	0.6
4	0.69	3	2¼	7.33	89.8	1.56	1.54—	1.53	1.3	1.9
3	0.67	3	2¼	7.65	88.8	1.55	1.56	1.54	0.6	0.6
					1:1¾:3¾ MIX					
1	0.63	4	3¾	8.75	84.4	1.55	1.56	1.53	0.6	1.3
2	0.67	3½	3⅜	8.39	85.3	1.54	1.53	1.52	0.6	1.3
4	0.69	4	2¼	7.83	89.6	1.49	1.49	1.48	0	0.7
5	0.72	2½	2¼	7.79	89.0	1.49	1.49—	1.49	0	0
3	0.68	5	3¼	8.15	92.1	1.47	1.48	1.47	0.7	0
					1:2½:4¾ MIX					
1	0.74	......	3¾	8.75	84.4	1.20	1.23	1.19	2.5	0.8
2	0.89	3½	3⅜	8.39	85.3	1.18	1.19	1.18	0.8	0
4	0.85	2½	2¼	7.83	89.6	1.15	1.17	1.16	1.7	0.9
5	0.97	2½	2¼	7.79	89.0	1.15	1.15	1.16	0	0.9
3	0.85	4	3¼	8.15	92.1	1.14	1.15+	1.14	0.9	0

(2) Computed from Taylor and Thompson's formula.

(3) Computed from Equation 1.

It will be observed that the variation of the estimated quantities from the experimental ones is generally less than 1 per cent. It should be pointed out, with reference to Equation 1, that the estimated quantity of materials per unit of volume of concrete will *never be less than that actually required* if the correct proportions, weights and specific gravities are used. The equation may give quantities somewhat greater than those actually used, depending on the amount of unfilled void space or entrained air. Where the measured quantities are apparently greater than the computed ones, either incorrect factors have been substituted in Equation 1 or an error has been made in measurement. It will be seen that loss of material from the batch would, for example, result in higher quantities of materials per unit of volume of concrete than that correct for the proportions.

Network of Highways Proposed

The construction of an elaborate system of super highways, greatly enlarging the Federal-aid highway program, which provides for 182,000 miles of Federal-aid road, has been asked in a bill just introduced in Congress by Senator George H. Moses of New Hampshire. The measure provides for a highway as direct as practicable between the Atlantic and Pacific coasts and for cross highways, which would connect the entire United States.

Iowa Products Association Officers

During the sessions of the Iowa Concrete Products Association, held jointly with that of the Wisconsin organization, at Milwaukee, the following officers were elected for 1928: president, Geo. T. Wilhelm; vice-president, Fred Popenhagen, and secretary-treasurer, R. L. Gavin.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit, Michigan.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 W. Grand Ave., Chicago.

American Construction Council; Dwight L. Hoopingarner, Executive, 28 W. 44th St., New York City.

American Engineering Standards Committee; Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth St., New York City.

American Road Builders' Association; Miss E. A. Birchland, Secretary, 29 W. Thirty-ninth St., New York City.

American Society of Civil Engineers; Geo. T. Seabury, Secretary, 33 W. Thirty-ninth St., New York City.

American Society for Testing Materials; C. L. Warwick, Secretary-Treasurer, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

Associated General Contractors of America; D. H. Sawyer, Secretary, 1150 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; Wharton Clay, Commissioner, 123 W. Madison St., Chicago.

Association of Cast Stone Manufacturers; Frank M. Brooks, Secretary, Pasadena, Calif.

Building Officials Conference of America; H. E. Plummer, President; Fred W. Lumis, City Hall, Springfield, Mass., Secretary.

Concrete Products Association; F. O. Matthiessen, Secretary, 644 Drexel Building, Philadelphia, Pa.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago.

Iowa Concrete Products Association; Floyd Goodrich, President; R. L. Gavin, Secretary-Treasurer, 405 Hubbell Bldg., Des Moines, Iowa.

National Association of Building Trades Employers; A. E. Coleman, President; A. W. Dickson, Executive Secretary, 2226 Builders Building, Chicago, Ill.

National Association of Builders' Exchanges; William F. Chew, Baltimore, President; Earl F. Stokes, Secretary, 15 E. Fayette St., Baltimore, Md.

National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.

National Fire Protection Association; Franklin H. Wentworth, Secretary, 40 Central St., Boston, Mass.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 E. Twenty-second St., New York City.

The National Lime Association; G. B. Arthur, Secretary, 927 Fifteenth St., N.W., Washington, D. C.

National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 432 Munsey Building, Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, 933 Leader-News Building, Cleveland, Ohio.

Northwest Concrete Products Association; F. R. Zaugg, Executive Secretary, 803 Seaboard Building, Seattle, Wash.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

Portland Cement Association; William M. Kinney, General Manager, 33 W. Grand Ave., Chicago.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary, Builders' Building, 228 N. La Salle St., Chicago, Ill.

Wisconsin Concrete Products Association; E. B. Bushnell, Secretary-Treasurer, 425 E. Water St., Milwaukee, Wisconsin.

Mixer Musings

Reported by "Joe"—The Mixer Boss.

Joe Goes to the A. C. I. Convention

DISGUISED as one of these highbrow engineers, and putting on my other suit of clothes, I hopped the train for Philadelphia, to have a look-in at this American Concrete Institute meeting.

Maybe the editor will get sore when he sees this report back here, but I just got to tell you guys that that convention was a wow! And there were a lot of Slump Testers there, too. Even the Grand High Truncated Cone was there, and you should have heard him tell 'em in the discussions.

Now, this here subject of "workability" that they talked about so much is right in my line. Felt good to see these big guys in the business get right down to a practical subject like that. There is a subject I know something about. I wasn't a mixer boss for so long without getting some real dope on what workability means. Made me feel good to know that the fellers that make the specifications are looking at the thing from the side of the men on the job.

But one thing I got to register a kick about. Those darn chairs were too hard for a hard working bunch like these institute fellers. Why, they never did know when to quit. Sessions morning, afternoon and night. Quit when they got through even if it was morning again. Well, I suppose they had to stick to it to get all those things off their chests. Next year I'll bring a whistle to let 'em know when it's quitting time.

Say, that stop-and-go signal they had on the chairman's table was hot stuff. Squelched any desire anybody may have had to "orate." That's one thing that spoils a lot of conventions. But not this one. They had to have something like that to give everybody a chance to tell what they knew.

Wonder how many Guild members were there? Maybe we can think up some way that one Slump Tester can recognize another at the next convention. A secret sign or a rose in his buttonhole or something like that. Tell me what you think about it. We might even all get together at noon so somebody could buy me a lunch.

Many a world beating house-building system has gone to the ashcan, 'cause the inventor knew little about concrete.

Cement and water are both essentials, but you will get into more trouble by cutting down on the cement than by cutting down on the water. You may not be able to shake a cement sack at the mixer and call it concrete, but you will get higher strengths if you let the mixer get its charge and do its work. And don't take the batch out too soon, either.

I know a fellow who made his men walk up twenty stories, and the lost time would have more than paid for the use of a temporary elevator. Reporters and inspectors are good at climbing ladders, even as good as cement finishers.

Yours for the proper slump
Joe, the Mixer Boss.

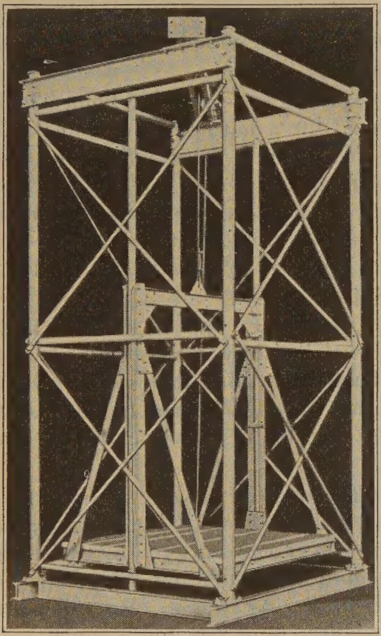
New Equipment and Materials

An Improved Material Tower Produced by Lakewood

The Lakewood Engineering Company of Cleveland, Ohio, on its 1928 pipe material tower introduces a method for eliminating nuts and completely protecting bolt threads from the weather.

Cages are built in two sizes, one for two wheelbarrows and one for three wheelbarrows. An elevator bucket can be used for handling concrete on the material elevator cage when desired.

Lakewood towers are said to have six fewer loose pieces for every 6- by 6-inch section of tower, than most towers; require two less bolts, no nuts, and have all intermediate section bolt threads protected from the weather. These features insure easier erection and dismantling and greater salvage and easier warehousing.



Standard towers can be built to a height of 300-ft. either single or double cage and can be increased in height to 400-ft. by the addition of 100-ft of extra heavy section.

Figures taken from actual jobs indicate according to the manufacturer that the single cage towers can be erected at a cost of one-half man hour per foot and the double towers at a cost of one man hour per foot, with fairly efficient labor.

Servicised Makes Additions to Its Products In Concrete Field

The Servicised Products Corporation, Chicago, announces that it is now manufacturing expansion joint with felt sides, a matted felt fibre core, in addition to its regular style "B" Joint.

Servicised is also introducing Cork Seal Joint which comprises 75 per cent asphalt, 18 per cent ground cork and 7 per cent fibre. This is primarily for buildings and where high resiliency is required in an expansion joint.

Servicised is also introducing Gray Crown Joint for municipalities in a commercial way and has so increased its facilities that it can make prompt delivery to every part of the country.

The corporation has doubled its plant capacity over 1927 and has acquired property at New Orleans for the manufacture and distribution of expansion joint at that point.

New G-E Drum Switches for Small Motors

The General Electric Company, Schenectady, New York, has made announcement of three new drum switches to be used with squirrel-cage and slip-ring motors and designed for the control of small cranes, hoists, machine tools, etc.

The CR-3200-1250-A is a primary resistance drum switch for squirrel-cage motors, providing four points forward and four points reverse and is suitable for motors that do not have an overhauling load.

The CR-3200-1250-B is a primary resistance switch for squirrel cage motors, giving four points forward and one point reverse. This switch is suitable for use where there is an overhauling load, that is, on hoists, this switch may be used where a worm gear or automatic mechanical load brake is not used.

The CR-3202-1308-A is a primary and secondary reversing switch for slip-ring motors, providing five points forward and five points reverse. It is suitable for starting duty or speed-regulating duty, and for use with 220-, 440- and 550-volt motors, rated 15 horsepower and less, where a five-point switch would be chosen.

All three switches have the same frames, but the cylinder developments are different. Horizontal handle, vertical handle, and rope wheel and spring return attachment are interchangeable.

New Building Paper Has Multitude of Uses

Sisalkraft is a new type of building paper being used in a variety of ways on structural and road work. Beside being useful as a covering in winter work, it is used for protecting exposed materials from the elements.

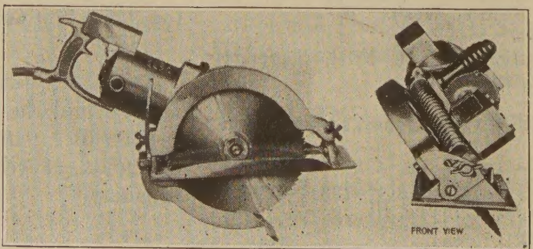
The paper is made of two layers of heavy kraft paper reinforced with two layers of strong sisal fibres running crosswise in both directions between the paper layers. Two layers of heavy asphaltum are then applied and all the materials pressed together while hot under pressure, resulting in a unified product that is said to be strong, flexible, and easy and pleasant to handle.

The Sisalkraft Company, Chicago, Illinois, is the manufacturer.

Wodack Saw Provides for Bevel Sawing

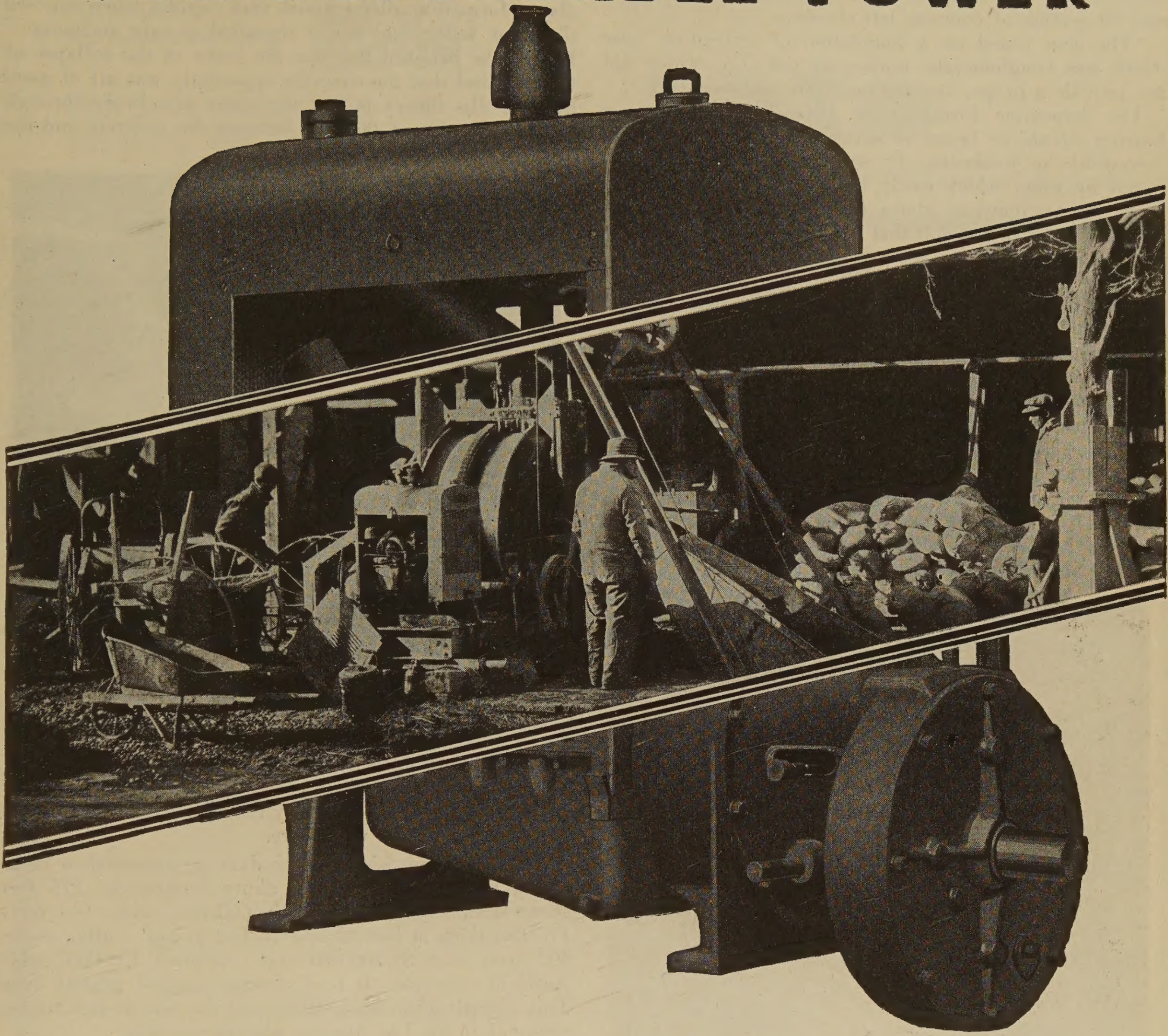
In addition to vertical sawing, the Wodack portable electric hand saw provides for bevel sawing at any angle up to 60 degrees. The "width gauge" is another new feature, for vertical sawing. The gauge can be set for any width from 0 to 6 inches. With it, various widths of strips can be sawed without the necessity of marking.

The bevel sawing is accomplished by a tilting saw-base which can be set and locked at any angle within the range of 60 degrees by means of a slide and locknut.



Like other types of this make, the Type B has a G. E. Universal motor of special design operating on both A. C. and D. C. and is furnished in 110-volt, 220-volt and 250-volt. Each saw is furnished complete with one 11 inch and one 9 inch blade.

FOR DEPENDABLE POWER



CONSISTENT—dependable power. After all, that's the sum and substance of the Le Roi. Its performance is unquestioned. Consequently, it has won national favor.

Besides being a reliable power unit of "liberal" rating—the Le Roi Engine costs less to operate per day and per year.

Le Roi is an engine of unusual merit—of extraordinary ability. Look to it for dependable power.

Le Roi Company, *Milwaukee*

LE ROI ENGINES

3 *to* 160 HORSE POWER

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California power company after examining the dam site and the section of concrete left standing.

"The dam rested on a foundation of serpentine, over which was conglomerate, topped by red clay, which did not provide a proper foundation," this engineer said.

The serpentine formation is a hard rock substance bearing streaks or layers of softer substances. These are susceptible to weakening by seepage. They were penetrated by water which easily found its way through the layer of conglomerate above it, with the result that the foundation became so soft that it would no longer hold up the tremendous weight placed upon it by the concrete structure and the water behind it.

Although criticizing the foundation of the dam, this engineer said the performance of the dam itself was a strong argument in favor of this type of gravity dam. The fact that the central section of the dam remained virtually intact despite the tremendous pressure and erosion should recommend it.

Another engineer, a member of the American Society of Civil Engineers, said that he found side walls of shale in the canyon in two strata, the lower apparently the softer. No hard rock was in sight at either side of the canyon, he said. "So far as visible, both sides of the canyon are of shale, which has been washed away to so great an extent that they do not show where the concrete structure of the dam was anchored. This argillaceous, or clayey formation, disintegrates very rapidly when exposed to air or water, and is not regarded as safe anchorage." He said he believed this was the cause of the collapse of the dam and that the concrete apparently was all of good quality. His theory is that the water first broke through on the west side of the dam between the concrete and the shale wall, and washed the wall away until it collapsed of its own weight. Then, he believes, the water swirled against the east wall and washed away the connection between the dam and the canyon wall there.

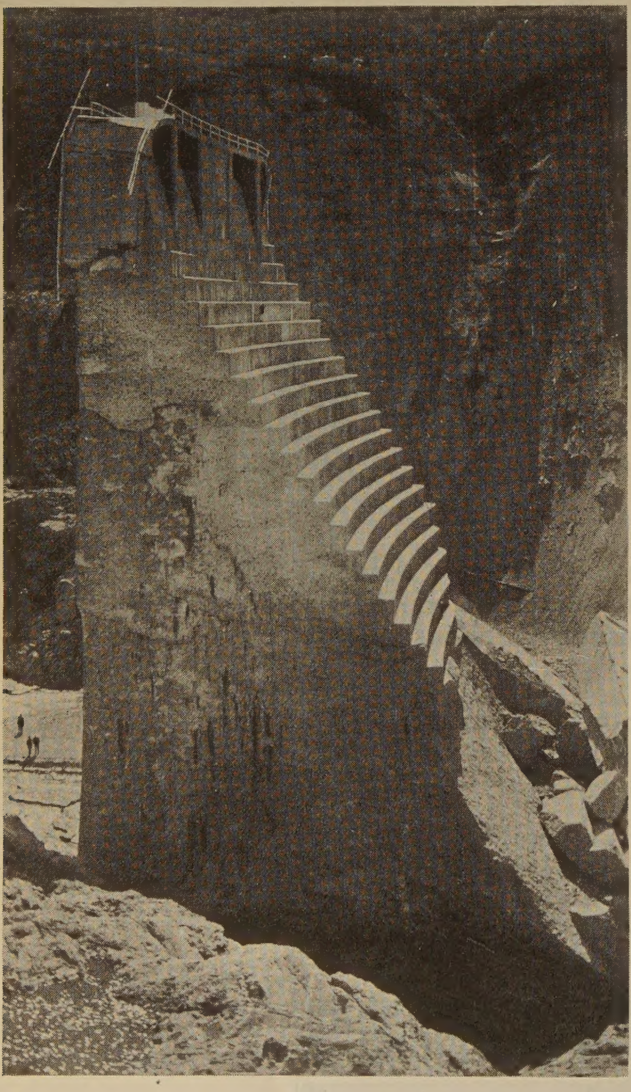

Figure 2. Showing the center 100-foot section which remained standing in spite of the intensive erosion of the foundation, as shown in the foreground

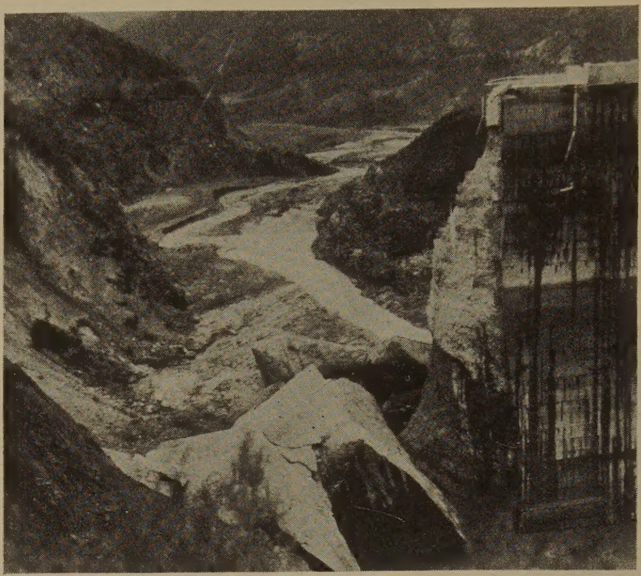

Figure 3. Looking downstream from the reservoir side, showing the great boulders broken from the east wing of the dam

The exact dimensions of the dam are reported to be as follows: 205 feet in height above foundation, 175 feet above stream bed; crest length, 668 feet; dyke, 613 feet; 175 feet thick at bottom and 16 feet at top; radius angle, 492 feet; cost $1,300,000 and contained 156,000 cubic yards of concrete. It is a concrete curved gravity type dam, completed in May, 1926, and was the second largest reservoir in the Los Angeles aqueduct system.

Investigations of the cause of the failure have been begun by the Los Angeles City Council, the Board of Supervisors of Ventura County and the state of California. The dam was designed by the Los Angeles Bureau of Water Works and Supply and built by it by day labor. William Mulholland is chief engineer of the bureau.

Additional information regarding the findings of the various investigating bodies will be published from time to time as they are made available.

Work Begins on World's Longest Promenade

Work was recently commenced on the construction of a concrete sea defense wall at Fleetwood, England, which will eventually lead to the formation of a continuous promenade and seaboard road for a distance of approximately twenty miles, thus forming the longest promenade in the world. The wall will be 6.000 feet in length, and will connect up with the present school promenade and sea wall. It is estimated that the work will take about a year to complete.